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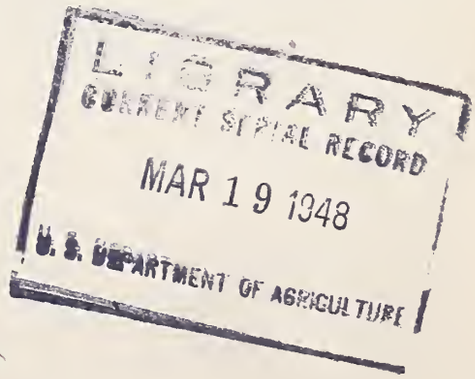
February 20, 1948

UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Administration
Bureau of Entomology and Plant Quarantine

RESULTS OF CODLING MOTH INVESTIGATIONS, 1947

Part I

Work Conducted by State Agencies,
Entomological Branch, Canadian Department of
Agriculture and Commonwealth of Australia
and
Commercial Entomologists



Not for Publication

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This pool of information on the results of codling moth research for the season of 1947 is the fifteenth of a series of similar summaries prepared by the Bureau of Entomology and Plant Quarantine, Agricultural Research Administration, U. S. Department of Agriculture, at the request of the Committee on the Codling Moth of the American Association of Economic Entomologists. These data are assembled for the confidential information of workers who are interested in the codling moth problem. The material is not for publication and is therefore not available for quotation or other use without specific permission from the agency which has furnished it.

Because of the general interest in pest control problems arising from the use of DDT for codling moth control in apple orchards and their close relationship to the codling moth spray program, information is included on such problems in this pool of information. The more important such problem pests at the moment include orchard mites, red-banded leaf roller and the woolly apple aphid.

ARKANSAS

Dwight Isely, Arkansas Agricultural Experiment Station, Fayetteville.

Injury by the codling moth in Arkansas in 1947 was distinctly less than for the average of the past 25 years. In part this was because the weather, during the period of emergence of the overwintering brood, was unfavorable to it. The first brood was very late. Probably a more important factor was that DDT for the first time was generally used in spraying apples in Arkansas. This insecticide was substituted for arsenate of lead, in most of the applications beginning with the last sprays for the first generation and throughout the summer. The season was also marked by severe injury caused by Tetranychid mites and the San Jose scale. This was the first year that mites caused any general injury in this region. The damage which they caused was far in excess of that caused by the codling moth this year.

The experimental work in codling moth control involved chiefly a further comparison of the effectiveness of DDT and arsenate of lead. The so-called DDT plots were sprayed with arsenate of lead in the calyx and the first two cover sprays. In all of the later applications DDT was used at the rate of one pound of actual DDT to 100 gallons. The arsenate of lead plots were sprayed with this insecticide in all applications throughout the season at the rate of three pounds to 100 gallons. The harvested fruit from the DDT plots was 5.83 percent wormy; in the arsenate of lead plots, it was 14.22 percent wormy. This difference was more distinct than it was during the two previous years.

DN-111 used at the rate of 1.25 pounds in 100 gallons gave satisfactory mite control. No injury was noted. At the time this material was applied, the maximum temperatures passed 100° F. for several hours a day. This was also during the period of severe drought.

CALIFORNIA

A. E. Michelbacher and W. W. Middlekauff, University of California, Berkeley.

Investigations on Walnuts (Payne Variety) at Linden

The past season's investigations again clearly demonstrated that standard lead arsenate is much more effective against the codling moth than is basic lead arsenate. A single spray of the former applied on May 1 at the rate of 3 pounds to the 100 gallons was as effective as two sprays of basic lead arsenate used at the rate of 4 pounds per 100 gallons, and applied May 1 and June 2. The addition of the basic zinc sulfate safener to the standard lead arsenate spray did not reduce the effectiveness of the material. Although a single spray of standard lead in early May gives good control, everything possible should be done to increase its effectiveness. The studies of the past season indicated that the addition of a depositor to the spray mixture increased the deposit, and improved the control obtained. It therefore appears that the addition of a depositor to the standard lead arsenate spray is desirable, and if one is added the manufacturer's recommendations should be carefully followed.

DDT resulted in excellent control of the codling moth. Good control was obtained where a spray containing 1/2 pound of actual DDT was applied on May 1. Where used at this dosage there is less danger of a destructive orchard mite population developing than where a pound dosage is employed. The lower dosage is also less favorable to an increase in the frosted scale population than is the higher one. However, unlimited recommendations concerning the commercial use of DDT cannot be made pending further experimental commercial testing.

Based on the 1947 season investigations, it appears that the addition of an aphicide to the early codling moth spray is a worth-while procedure. The addition to the early May codling moth spray of 1 pound of a 14 per cent dry nicotine concentrate, or 1 pound benzene hexachloride (gamma isomer 6 per cent), or 1/2 pint of a 50 per cent mixture of organic phosphates all resulted in very satisfactory control of the walnut aphid. Because the dry nicotine concentrate is likely to have less adverse effect upon predators than are the new insecticides, it probably is the safest material to recommend until the others have further stood the test of time.

There are no reports where standard lead arsenate used with the safener has caused any injury to walnuts, and because investigations have shown it to be much more effective than basic lead arsenate, it appears that unlimited recommendations for its use can be safely made.

Satisfactory control of the codling moth is dependent upon the thoroughness with which sprays are applied. One properly applied spray early in May before the first brood of caterpillars begin to enter the nuts should result in satisfactory control. A second spray applied during the first half of June will improve the control, but it appears that the added benefit obtained would hardly justify the cost of treatment.

At the present time it appears that the most satisfactory spray that can be recommended for general use is as follows:

Standard lead arsenate	3 pounds
Safener (Delmo Z, a commercial basic zinc sulfate product containing 50 per cent zinc expressed as metallic)	1 pound
14 per cent dry nicotine concentrate	1 pound
Light medium summer oil emulsion containing 83 per cent oil	1/3 gallon
Water	100 gallons

Order of mixing: Lead arsenate and safener slurried together, nicotine slurried, former added to tank when 1/3 to 1/2 full, followed by oil then the nicotine.

If desired, 1/4 to 1/3 pound of a depositor can be added to the above spray. It should be slurried with the lead arsenate and safener.

The following DDT spray is recommended for growers who would like to use this insecticide on a limited acreage:

50 per cent DDT wettable powder	1 pound
DDT depositor	1/3 pound
14 per cent dry nicotine concentrate	1 pound
Light medium summer oil emulsion containing 83 per cent oil	1/3 gallon
Water	100 gallons

Order of mixing: DDT and depositor slurried together, nicotine slurried, former added to tank when 1/3 to 1/2 full, followed by the nicotine, then the oil.

In order to avoid a serious increase in the walnut aphid population, an aphicide should always be added to DDT sprays of the above concentration.

In order that the advantages of DDT may be utilized and its disadvantages held to a minimum, it is believed that a codling moth spray program might be developed whereby a DDT and standard lead arsenate spray schedule can be used on alternate years.

A new insecticide known as 3422 has made its appearance. This material has been found to be very efficient in controlling many pests including aphids and mites. Sufficient investigations have been conducted to indicate that this insecticide might well be used in conjunction with DDT to reduce if not eliminate the danger of destructive aphids, mites, or frosted scale populations developing.

Investigations at San Jose

In the San Jose area it appears that the codling moth is by far the most important pest infesting walnuts. Although present, the Catalina cherry moth appears to be of little importance, but there may be orchards in certain localities that were not observed where it is a major pest.

In substantiation of the investigations at Linden, it was found that one spray of standard lead arsenate with safener was as effective as two sprays of basic lead arsenate. One spray of DDT appeared to be no more effective than a single spray of standard lead arsenate.

It was found that the first brood of codling moth was later getting started at San Jose than at Linden. In the experimental orchard at Linden, 2 percent of the developing walnuts were infested on May 1 while in the experimental orchard at San Jose no infested nuts were found as late as May 7 and even on May 21, only 4 percent of the nuts in the check plots were infested. In order to show the relationship that exists between the two areas, figure 1 has been prepared. Shown is the seasonal trend of infestation in the developing nuts of the check plots in the experimental fields of the two areas. If studies in following years substantiate the above finding, the important thing will be that the May spray for efficient control can be applied at a much later date at San Jose than at Linden.

The absence of a first brood of moths developing in the orchard at Campbell (figure 2) creates a rather difficult problem. Certainly, if an infestation is going to result from migrating moths which developed on another crop, there is no need of applying a spray in May. The application of control measures could well wait until after June 15. The question is how frequent is the above condition encountered?

Results with standard and basic lead arsenates in the San Jose area were similar to those at Linden. This further confirms the indication that standard lead arsenate can safely be recommended for the control of the codling moth on walnuts. For the May spray in this area it should be used with a safener and aphicide in the same manner as recommended for use at Linden and applied thoroughly before the first brood of caterpillars start entering nuts. If a grower should want to use a DDT spray on a portion of his acreage, the formulation and precautions given in the report for Linden should be followed.

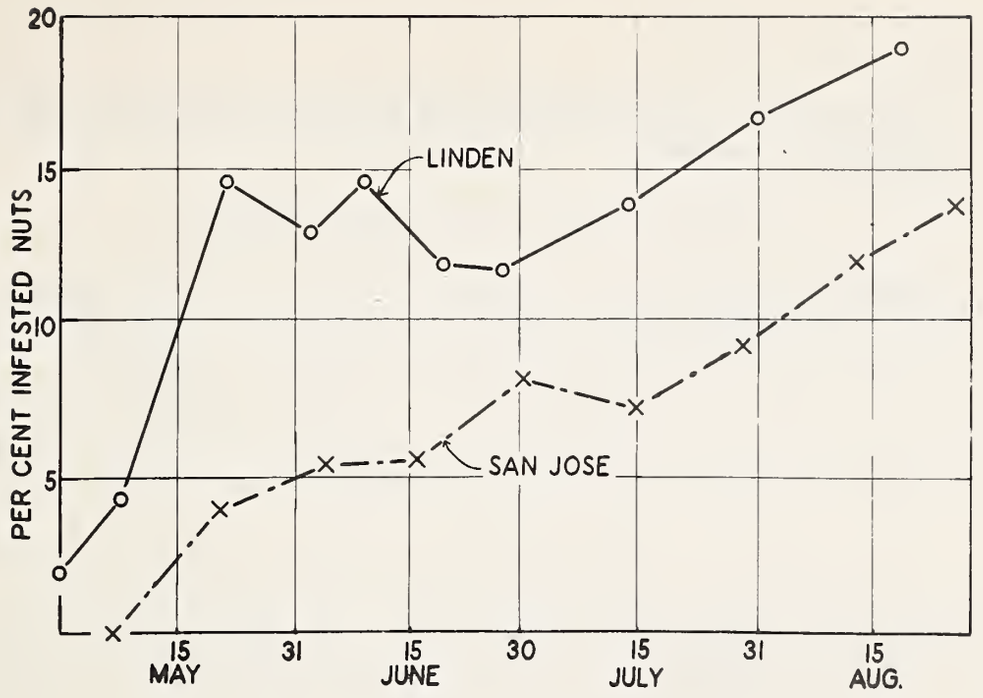

Fig. 1--Seasonal trend of infestation in the developing nuts in the check plots at Linden and at San Jose.

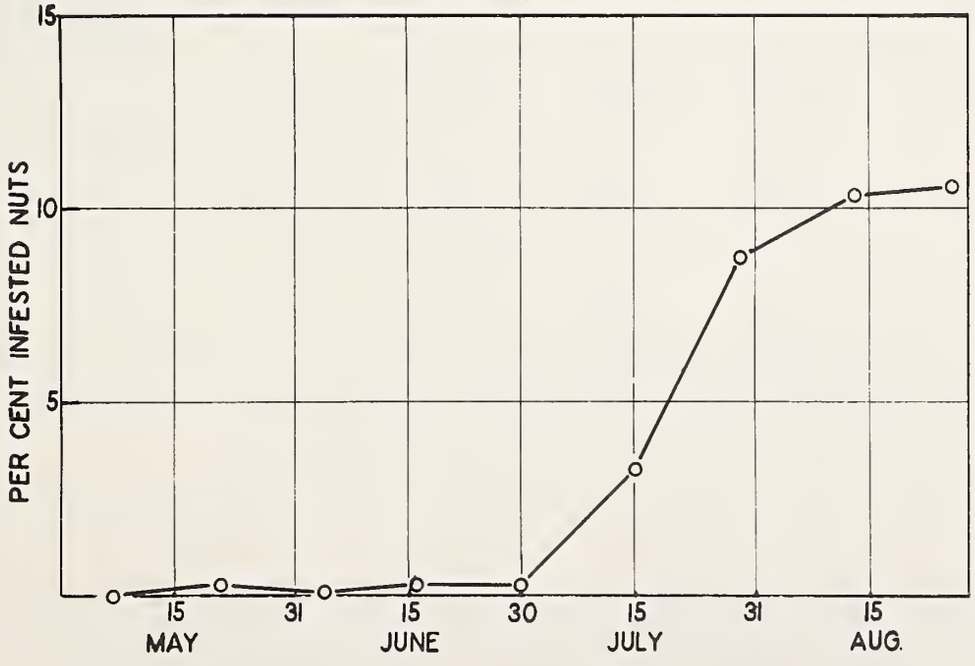

Fig. 2--Seasonal trend of infestation in the maturing nut crop in the check plot at Campbell.

CALIFORNIA (Continued)

M. M. Barnes, University of California, Citrus Experiment Station, Riverside.

(Report attached as a part of this pool of information.)

COLORADO

J. H. Newton, Colorado Agricultural Experiment Station, Paonia.

Codling Moth Control in Colorado

Codling moth control in Colorado consisted of two major projects, namely; (1) Control on pears in Mesa County and (2) Control on apples in Delta County. These represent two distinctly different problems of moth population and mite problems. In our studies of the past season we considered mite control of primary interest and codling moth control secondary.

Control on Pears (M. L. Dilley Orchard, Clifton, Colo.)

Four spray schedules were replicated four times on plots of 15 trees each. All harvest and drop fruits were scored from four trees of each plot. No calyx sprays applied in any schedule.

Treatment	Total Fruit	Clean Fruit	Wormy Fruit	Stung Fruit	Calyx Wormy
4 Cover Sprays 3 DDT 3/4#-100 1 DDT 1/2#-100	12496	12383 99.2%	81 0.6%	32 0.2%	18
4 Cover Sprays DDT 3/4#-100	13131	13076 99.6%	43 0.3%	18 0.1%	11
3 Cover Sprays DDT 3/4#-100	11491	11366 99.1%	103 0.8%	22 0.1%	19
4 Cover Sprays DDT 1/2#-100	13717	13578 99.0%	112 0.8%	27 0.2%	26

DN-111 applied in the first and second cover sprays 3/4#-100 for mite control. Also repeated August 1 ten days before harvest.

There was no significant difference between any of the above treatments on pears.

It should be noted that the calyx spray was omitted from all plots. This is the third year in which experimental tests have proven the calyx spray to be unnecessary on pears and apples when a DDT spray program is used. Codling moth control was excellent considering the fact that the moth population as indicated by flight records of the first brood was double that of 1946. (From 175 to 200 moths per night in five traps at the peak of the flight.)

DN-111 (Dinitro-o-cyclohexyl phenol) combined with the first and second cover sprays held the Brown mite (clover mite) well in check until about ten days previous to harvest at which time a late application was necessary to check a heavy mite flare up. A few two spotted mites showed up late in the season in conjunction with wild morning glory or bindweed infestation.

Control on Apples (Tom McKee Rome Beauty Orchard, Paonia)

Five spray schedules were compared in a latin square arrangement. The spray plots were laid out in squares of 4 x 4 or sixteen trees each. Counts were made of harvest and dropped fruit from the inside four trees of each plot.

During the past three seasons Dr. Geo. M. List and the Research Statistician of the Experiment Station have made regression studies of the codling moth data. Adjusting the data upon a uniform crop basis materially changes the rank of certain treatments in any codling moth control experiment. Therefore the interpolation of all results have been considered upon such a basis. (It is hoped that a more detailed report of this study will be made in the future.)

Rome Beauty Apples. Paonia, Colo. 1947

Test No.	Treatment	Total Fruit	Clean Fruit	Wormy Fruit	Stung Fruit	Calyx Wormy
6	4 Cover Sprays DDT 3/4#-100 5th cover omitted	13983	13022 93.2%	619 4.4%	342 2.4%	3
7	5 Cover Sprays 3-DDT 3/4#-100 2 DDT 1/2#-100	8974	8347 93.1%	394 4.3%	233 2.6%	6
8	5 Cover Sprays 4 DDT 3/4#-100 1 DDT 1/2#-100	11201	10659 95.2%	284 2.5%	258 2.3%	1
9	5 Cover Sprays 5 DDT 1/2#-100	8724	7801	550	323	5
10	5 Cover Sprays Split schedule 2 DDT 3/4#-100 1 B.L.Blend 3#-100 2 B.L.Blend + summer oil	11371	10976 95.5%	250 3.4%	145 1.1%	4

Analysis of Apple Spray Data 1947

Treatment	Mean Total Fruit	Mean Wormy Fruit	Original Rank	Adjusted Mean Wormy Fruit	Adjusted Rank
6	2796.6	123.8	5	68.5	3
7	1794.8	78.8	3	111.9	4
8	2240.2	56.8	2	50.6	2
9	1744.8	110.0	4	147.5	5
10	2274.2	50.0	1	40.8	1

Minimum difference for significance:
5% point 58.99
1% point 83.25

Regression studies were made and the minimum difference for significance determined. The minimum difference for significance may be applied to both the original and the adjusted groups.

Taking No. 8 as the check or standard treatment we note in the adjusted crop values that treatments No. 6 and 10 are not significantly different from the standard. The addition of the fifth cover spray as in No. 8 did not contribute much to the control over the four cover sprays as in No. 6. The split schedule using the Blend for second brood control was equal to the straight DDT schedule.

The difference between No. 8 and 9 is highly significant whereas the difference between No. 8 and 7 approaches high significance.

Reducing the DDT to one half pound in the fourth and fifth cover application as in No. 7 and all through the season as in No. 9 materially lowered the efficiency of the DDT.

The importance of adjusting to a uniform crop basis is clearly seen when we examine the effect upon treatment No. 6. Without adjustment it is the least efficient treatment whereas with adjustment it becomes equal to No. 8 and 10 which were the most efficient ones without crop adjustment.

Residues at Harvest

All of the residues at harvest time ran below the tolerance for both apples and pears, with but one exception.

Treatment	Residue ppm	Treatment	Residue ppm
No. 1	6.9	No. 6	3.7
No. 2	7.0	No. 7	3.6
No. 3	8.4 1/	No. 8	4.1
No. 4	4.7	No. 9	3.4
		No. 10	6.0

1/ There is no logical reason why this sample should have run above the tolerance as the actual amount of DDT applied throughout the season was below all of the other treatments except No. 4.

For the apples the use of oil in the last two cover sprays gave the highest amount of residue.

Mite Control (Apples)

Due to the necessity of combining wettable sulfur in the first three cover sprays for the control of powdery mildew of apple, it was impossible to carry through certain miticide tests which were planned for the experiment. This particular orchard was heavily infested with brown mite and red spider (two spotted mite) species in 1946. The use of wettable sulfur in the three cover sprays for 1947 evidently gave sufficient control to ward off any flare up of mite population during the season. Mite populations were high and on the increase throughout most of the district in 1947.

Predators and Parasites

At the close of the season there seemed to be a normal population of Chrysopidae, Coccinellidae, and Syrphidae larvae and adults, in those orchards sprayed with DDT. There was an evident reduction in the Aphelinus mali species on the woolly apple aphid.

The upsurge of mite populations which have occurred during the past three seasons may or may not be the direct result of the use of DDT in codling moth control. In fact we were having some very definite mite problems before the advent of DDT and we have experienced heavy mite populations in orchards which never have received a DDT spray. There is need for more actual data in the study of mite populations in Colorado.

DELAWARE

L. A. Stearns, Delaware Agricultural Experiment Station, Newark

Seasonal Conditions and Codling Moth Abundance

Codling moth abundance, in 1947, was approximately the same as in 1946. Crop losses from this source for these two years are the lowest of record. In one orchard in which lead-oil-nicotine was previously the accepted schedule, bait trap catches for 1943, '44, and '45 averaged 1546 moths; in 1945 and '46, under the present lead-DDT program, the catches averaged 103 moths -- a reduction of 93%. This example is indicative of the population trend in well-sprayed plantings throughout the State. The reverse situation is presented by blocks in different areas, which suffered heavy frost damage on the nights of May 8, 9, and 10, 1947, and, therefore, received no sprays following the petal fall application. These neglected blocks will require intensive treatment during 1948 to insure a satisfactory crop.

Emergence of the spring brood, in 1947, commenced April 24 and ended June 19, with 90% of the moths appearing in May. Emergence of the first brood commenced July 3 and ended August 6, with 99% of the moths appearing in July. With the periods of adult activity so well defined, the lead-DDT program and the straight lead and straight DDT schedules as well (treatments 4, 3, and 1 in the accompanying table) -- with sprays recommended on May 2, 16, and 26; June 7 and 21; July 5 and 19; and August 2 -- proved highly effective.

Experimental Spraying for Codling Moth Control

(in cooperation with W. LeRoy Parker)

DDT, Toxaphene and Lead alone, DDT and Lead, and Toxaphene and Lead were compared for codling moth control in the rectangular block of 322, 20-year-old, Red Delicious apples used for similar studies in 1946, 1945, and 1944. This planting was divided into five plots (of 55, 55, 66, 69, and 77 trees, respectively), so arranged that one plot (lead alone), three rows wide, transected the others centrally. Seven applications (a petal fall and six cover sprays) were made with a 500-gal. speed sprayer (rate, 15 gals. per tree) on the following dates: May 9 - petal fall, 26, June 4, 14, 28, July 10, and 29.

Lead arsenate (3 lbs./100 gals.) was used with lime (3 lbs.) and flotation sulfur paste - 45% (12 lbs.) in the pre-blossom and petal fall sprays for all treatments; sulfur (8 lbs.), in the first- and second-cover sprays; and weak Bordeaux ($\frac{1}{2}$-3-100) in the third- , fifth- and sixth-cover sprays and (1-3-100) in the fourth-cover spray. The treatments of DDT and of Toxaphene alone included the toxicant at the rate of 1 pound in all covers except the fifth, where it was reduced to 3/4 pound. The treatment of lead alone was at the rate of 4 pounds in all covers. The treatments of DDT and lead and of Toxaphene and lead included lead at the rate of 4 pounds in the first-cover; DDT or Toxaphene (1 lb.) and lead (3 lbs.), in the second and third

covers; and DDT or Toxaphene (1 lb.) in the fourth, fifth, and sixth covers.

The results, as set forth in the accompanying table, should be self-explanatory. However, with respect to codling moth, it may be pointed out that both DDT and lead alone and DDT with lead gave almost complete control (97%). Toxaphene alone and Toxaphene with lead were approximately 15% less effective. This reduction is due wholly to wormy rather than stung apples, and is directly reflected in the higher percentages of dropped fruit in the case of these treatments. The combination of Toxaphene and lead was no improvement over Toxaphene alone. There was no significant difference between treatments in the size of the picked apples. Drop and harvest data agree closely. Oriental fruit moth and red-banded leaf roller injury was obviously unimportant. Plum curculio damage was decidedly more severe with DDT and Toxaphene than with lead. The percentage (55) marked by curculio in the case of the DDT and lead treatment is definitely out-of-line, but no explanation is apparent. The red mite population with DDT alone and with DDT and lead was moderately large; with Toxaphene and lead and with Toxaphene, small to negligible. Miticides under the conditions of application stated (rainfall immediately following spraying), proved less than 50% effective.

Summarized Drop and Harvest Records, Red Mite Counts, and Spray Residue Data[5],
Red Delicious Apple Planting, Rising Sun, Delaware, 1947

Treatments	Crop of Five Trees			Drop in %	Codling Moth					Oriental Fruit Moth	Plum Curculio	Red-banded Leaf Roller	No. Mites/Leaf[4]			
	Apples	Total Bushels	Apples per Bu.		Per cent			Worms	Stings				July			
					Clean	Wormy	Stung	per 100 Apples					7	14	21	27
(1) DDT[a]	D[1] 665 H[2] 7494 T[3] 8159	66.25	111	8.2	87.5 97.4	1.8 0.0	10.7 2.6	0.0	3.7	0.2	21.8	0.3	1.2	5.9	10.8	30.8
(2) Toxaphene[b]	D - 1652 H - 5023 T - 6675	45.00	112	24.7	35.6 81.0	56.2 17.4	8.2 1.6	26.9	4.0	1.3	23.1	0.3	0.1	0.2	0.8	4.4
(3) Lead[e]	D - 613 H - 5432 T - 6045	50.50	106	10.1	87.1 97.4	4.2 0.8	8.7 1.8	1.3	3.2	0.6	6.4	0.0	0.4	0.5	1.5	7.1
(4) DDT and Lead[c]	D - 521 H - 9160 T - 9681	72.75	125	5.4	86.0 97.4	2.5 1.4	11.5 1.2	2.0	1.8	0.1	55.4	0.1	1.2	5.4	11.5	50.4
(5) Toxaphene and Lead[d]	D - 1525 H - 7300 T - 8825	65.75	109	17.3	42.8 83.6	52.1 13.7	5.1 2.7	20.5	7.2	0.3	11.5	0.1	0.4	1.3	5.6	19.2

1/Dropped apples - total for June 30, July 14, 21, 31, Aug. 8, 18, 25, and Sept. 4, 1947.
2/Harvested apples - total for Sept. 16 and 24, 1947; 1250 -- 250 from each of 5 trees -- examined for each treatment.
3/Total dropped and harvested apples.
4/Miticides applied July 29, with rainfall 2 hours after spraying; reductions as of July 31 were as follows: Summer Oil (6 qts./100 gals.), 49%; Genicide (1 lb./100 gals.), 42%; and DN-111 (1.25 lbs./100 gals.), 37%.
5/Residues as of Sept. 16 (48 days after last cover spray -- July 29).
a/DDT -- 4.0 ppm; b/Toxaphene -- 1.7 ppm; c/DDT -- 1.4 ppm; As_2O_5 -- trace; d/Toxaphene -- 1.5 ppm; As_2O_5 -- trace; e/As_2O_5 -- 1.4 ppm.

IDAHO

H. C. Manis, Agricultural Experiment Station, Moscow.

We have not been conducting any experimental work on the control of codling moth in Idaho. However, we have had a chance to observe the results of the use of DDT throughout the apple-growing areas in Idaho. Of course, the results in codling moth control have been very excellent, and similar to those obtained in all other areas.

There has been, this past season, a very bad mite infestation, but it seemed to be just as heavy in orchards sprayed with lead arsenate as those sprayed with DDT. In my opinion, last season was an exceptionally favorable year for the build-up of mites. Of course, since we do know that some of the parasites of mites are killed off when DDT is used, there is not any doubt in my mind that infestations of mites and woolly apple aphids are increased, to some extent, by the use of DDT. However, due to the rapid decline in codling moth populations all over the apple-growing area, it may be only necessary to make one application of DDT for the first brood of codling moth and then allow the parasites to build back up to take care of mites and woolly apple aphids.

Our neighboring State, as you probably know, has been conducting some research on the use of aryl alkyl thionophosphate, and the results of their work have been so outstanding in the control of orchard mites and woolly apple aphids that they are going to recommend it for use in conjunction with DDT during the 1948 season. We are planning to follow suit since our conditions are quite similar to those that occur in Washington, and I am sure that if it does a satisfactory job there, it will do the same here.

ILLINOIS

S. C. Chandler, State Natural History Survey Division, Carbondale.

Orchard Tests with DDT for the Control of Codling Moth in Illinois 1947

The object of conducting these tests was to study the advantages and disadvantages of a DDT spray schedule on apples over the standard lead-nicotine schedule in common use, and to compare two newer forms of DDT, under the trade names of Codam and Nonpareil, with a standard schedule and one containing wettable powdered DDT. Unreplicated plots

were used, but they were located in a considerable number of orchards widely scattered over the State. Little supervision was given, occasionally not enough to keep the grower from mixing up his spray schedules and introducing a little DDT into his standard schedule, but it was our idea to see how the various growers would handle these schedules themselves.

The important data from the spray schedules is given in Table 1. It will be seen from this and Table 2 that the first five orchard tests were arranged for the sole purpose of comparing a standard and a DDT schedule. The relatively large number of lead arsenate sprays indicated in Table 1 even in the DDT plots was due to the fact that in most cases the calyx and two or three covers were the same in both blocks and contained lead arsenate only for the insecticide. The exact dosages of the various insecticides are not given but in most cases growers followed the recommended or suggested strengths given in our Extension Circular 610.

Summary and Conclusions - Codling Moth Control

1. Comparison Between Standard and DDT Schedules

Averaging the percentages given in Table 2 for the first five orchards and including Plots 2, 4 and 4A of the Smith orchard we find an average of 5.7 percent of the fruit wormy in the DDT blocks and 18.6 percent in the standard, or a ratio of 1 to 3.3. The ratios for the past two seasons have been as follows, DDT to standard, 1945, 1 to 3.3; and 1946, 1 to 2.3.

2. Comparison Between Wettable Powdered DDT and DDT in the Form of Codam and Nonpareil.

As it was used in the last three orchards listed in Table 2, Codam was inferior to powdered wettable DDT. In the Smith orchard where a standard schedule was used in one block it was not superior to the standard. Nonpareil in one orchard in two varieties was inferior to the powdered DDT and not superior to the standard. In 1946 in this same orchard (Smith) it was as efficient as the powdered wettable DDT.

Mite Injury

Mite injury was present in all DDT sprayed blocks but in no case severe. The contrast was not great between the DDT and the standard plots. It seems likely that this is in part due to the type of DDT schedule used. It will be seen by Table 1 that it was seldom used alone but in smaller dosages with lead arsenate or nicotine, and that the number of DDT sprays was not great compared with the total number of sprays.

Red-Banded Leaf Roller

The injury from red-banded leaf roller which was so severe in 1946 in some localities was very light in all the eight orchards in these tests. This is in part due to the spray schedules used in the DDT blocks. As is indicated in Table 1, lead arsenate was used in the early sprays entirely or later with DDT, and this probably reduced the first broods sufficiently to prevent later increase. Natural enemies also were probably an important factor, especially where the schedule did not run too heavy to DDT.

Oil-DDT and Other Foliage Injury

The number of times summer oil was used with DDT is shown in the last column in Table 1. The injury from this source was light, except in the Jeffries orchard where a combination of Nicosol and DDT seemed to give moderate injury. In every case the standard block had somewhat better foliage than the DDT block, though this was due to somewhat less injury both from mites and oil-DDT injury.

Fruit Injury from DDT

The effect of DDT on russeting and color at harvest was not very noticeable in any of the test orchards in 1947.

Table 1. Data from Spray Schedules in DDT Tests by S. C. Chandler in Illinois, Season of 1947

Orchard	Plot No.	Total No. Sprays	Date of Last Spray	Number of Applications With										
				Lead Ars. Alone 1/	Nicotine Alone	Lead & Nicotine	DDT 2/ Alone	DDT & Nicotine	DDT & Lead	Codam With Lead	Codam With Nicotine	Nonpareil Alone	Nonpareil & Nicotine	Oil With DDT
Jeffries	1	9	8/29	5	1			3						3
	2	9	8/29	3	1			3	2					5
Sauer	1	12	9/8	8	3		1							
	2	12	9/8	3			1	3	5					5
Foreman	1	8	8/22	5	2	1								
	2	8	8/22	2	1		1	1	3					2
Ringhausen	1	8	8/18	5	1	2								
	2	8	8/18	4				2	2					4
Thornton	1	8	9/10	4	3				1					1
	2	8	9/10	3	3				2					1
Eckert	1	12	8/26	3				1		3	5			1
	2	12	8/26	2				5	5					5
Nugent & Schapanski	1	10	8/18	3	1			2		2	2			2
	2	10	8/18	3	1			4	2					6
	3	10	8/18	3	1			4	2					6
Smith	1	9 3/	8/28	2	1				1	3	2			1
	2	9	8/28	5	1			2		1				1
	3	9	8/28	2	1							4	2	
	4 & 4A	9	8/28	2	1			2	4					5

1/ "Alone" means with no other poisons. May be combined with oil, fungicides or safeners.

2/ Material used wettable powder 50 percent.

3/ Nine sprays on Kinnards ending August 28, 8 sprays on Jonathans, ending August 19. Last spray on Kinnards nicotine only.

Table 2. Summary of Final Codling Moth Infestation Data Taken in DDT Apple Spray Tests in Illinois, Season of 1947.

Orchard	Plot No.	Type of Spray Schedule Materials Chiefly Used	Percent of Apples Wormy	Stung
Jeffries	1	Standard, lead-nicotine	15.4	10.0
	2	DDT	5.4	4.3
Sauer	1	Standard, lead-nicotine	56.7	38.7
	2	DDT	15.8	24.4
Foreman	1	Standard, lead-nicotine	2.0	1.7
	2	DDT	.3	.8
Ringhausen	1	Standard, lead-nicotine	24.0	7.9
Gold. Delic.	2	DDT	9.2	3.8
Wil. Twig.	1	Standard, lead-nicotine	12.4	5.4
	2	DDT	4.0	5.4
Thornton	1	Standard, lead-nicotine	9.7	3.7
	2	DDT	3.4	3.1
Eckert	1	Wettable, powdered DDT	8.5	9.1
Stayman	2	Codam	35.1	18.5
York	1	Wettable, powdered DDT	6.1	9.3
	2	Codam	17.3	16.7
Nugent &	2	Wettable, powdered DDT	1.2	3.8
Schapanski	3	Wettable, powdered DDT	3.0	2.0
	1	Codam	6.0	6.8
Smith	1	Codam	18.1	10.3
Jonathan	2	Standard, lead-nicotine	16.3	15.8
	3	Nonpareil	22.0	3.0
	4	Wettable, powdered DDT	3.8	1.7
	4A	Wettable, powdered DDT	3.0	2.3
Kinnard	1	Codam	13.2	12.8
	2	Standard, lead-nicotine	12.6	14.2
	3	Nonpareil	13.8	7.6
	4	Wettable, powdered DDT	3.6	4.0
	4A	Wettable, powdered DDT	4.8	6.8

INDIANA

G. Edward Marshall, Indiana Agricultural Experiment Station, Orleans.

For the past two years at Mitchell only two sprays containing DDT have been needed to control the codling moth and at the same time avert (but not control) the destructive attacks of spider mites resulting from the killing of the natural enemies of the mites through numerous applications of DDT.

A combination of Wyoming bentonite 5 pounds per 100 gallons of water, DDT 1.5 pounds of 50 percent powder, nicotine sulfate one pint and soybean oil one quart proved to be the most successful spray for apples and the combination was satisfactory even in the Elrod orchard planted in 1912, one which is widely known for its heavy infestation. Lead arsenate and oil with DDT also controlled although this combination causes some foliage injury.

The season's program began with a dormant spray applied March 20 to April 3 and contained 1/2-3/4-100 bordeaux with three percent oil. This was followed by 7 sulfur sprays and one of Fermate to control apple diseases.

Lead arsenate was added in the calyx application and two cover sprays following the calyx spray. By this time sulfur and other fungicidal materials were discontinued and DDT incorporated. The application of the first very thorough DDT containing spray was carefully timed to be put on just as the codling moths of the first brood were flying in large numbers and laying eggs but before egg hatch had begun to be conspicuous. This took place in 1947 about June 21 to 23 at Mitchell. A man on the ground sprayed the trees from the inside out and one using a tower sprayed them from the outside in. Such an application practically anihilated this apple insect for approximately 25 days.

Careful watch was kept for the renewal of entries of newly hatched codling moth larvae into the apples. About July 23 this began to take place and a DDT containing spray similar to the first one was used to combat attack. This application was completed July 31. These two sprays were all that were necessary after June 20 and through September 10. This timing, and the application of this combination, prevented a heavy hatch and entrance of larvae into the fruit so common in early September. A check of the fruit at harvest showed it to be less than 15 percent wormy. Such a program is most successful where apple scab has been efficiently controlled resulting in healthy foliage to properly mature the fruit.

Treatments of the Elrod Orchard in 1947 (Amounts based on 100 Gallons of Water)	Per 100 Apples at Harvest Affected	Wormy
Lead arsenate 3 lb. three sprays- Wyoming bentonite 5 lb., soybean oil 1 qt., nicotine sulfate 1 pt. in three sprays.	45.00	40.00
Lead arsenate 3 lb. three sprays-lead arsenate 3 lb., zinc sulfate 3 lb., lime 3 lb. oil 1/2 percent three sprays.	41.00	20.50
Lead arsenate 3 lb. three sprays- Black Leaf 155 3 lb., oil 1/2 percent one spray-Black Leaf 155 3 lb. six sprays.	26.00	15.50
Lead arsenate 3 lb. three sprays- Lead arsenate 4 lb., oil 1/2 percent, soap 1/2 lb. two sprays - Wyoming bentonite 8 lb. flocculated with soap and aluminum sulfate one spray.	21.50	6.50
Lead arsenate 3 lb. three sprays DDT 1.5 lb. of 50 percent powder two sprays.	14.90	13.20

KANSAS

E. L. Eshbaugh and R. L. Parker, Kansas Agricultural Experiment Station, Manhattan.

Codling Moth, Two-Spotted Mite and Red-Banded Leaf Roller Control During 1947

Introduction

Studies in northeast Kansas in 1944, 1945 and 1946 indicated the effectiveness of DDT as a codling moth insecticide and as a supplement to lead arsenate in apple spray schedules and those in 1945 and 1946 showed the possibility of the occurrence of the two-spotted mite in apple orchards where no miticide was used with DDT. Additional studies of DDT and other materials for codling moth control were made in northeast Kansas in 1947 and observations made on mite and red-banded leaf roller damage in the experimental plots.

Seasonal Conditions and Codling Moth Abundance

First Brood. The first recorded catch of codling moths during 1947 was two moths on May 24. Emergence started in cages May 21. Large numbers of moths were removed from bait traps during the first ten days of June. The numbers of moths in flight was low during the last half of June and the first half of July. The first larval entry was noted on June 5. June 10 to June 20 was the period of heaviest larval hatch. The usual short lapse of codling moth flight between the first and second broods in this area did not occur, although the number of moths removed from bait traps during this period was small.

Second Brood. On July 11, bait trap and emergence cage catches indicated the first brood moths had begun to emerge. Uniform numbers of moths, with few high and low catches, were removed from bait traps the first part of this brood period. A peak in the number of second brood moths was reached on August 10 and 11. Weather conditions throughout most of the second brood were hot and dry, resulting in some damage to the fruits from codling moth larvae.

Third Brood. Weather conditions favoring the rapid development of codling moths resulted in a partial third brood in northeast Kansas. Nine second brood moths were removed from emergence cages August 23, indicating an early third brood. Codling moths increased rapidly in number until a peak was reached on September 1. Large catches of moths continued to September 17. The most severe damage to fruit of the season occurred between September 8 and 20. The operation of bait traps was discontinued on September 20.

Seasonal Damage

Codling moth control was good in most orchards receiving the required number of first, second, and third brood cover sprays. As in 1946, the last three cover sprays were the most important. Only a small number of wormy apples was found following the first brood. Although many infested fruits were found late in the growing season, the apples harvested in northeast Kansas were more free from codling moth injury than in previous years.

1947 Tests

The combinations of insecticides used in 1947 are indicated in Table 1.

Table 1. Insecticides, dosages, and schedules used in control tests in pounds per 100 gallons of spray mixture.

Treatment in 100 Gallons of Water
All plots except the check had a calyx spray of 4 pounds of lead arsenate.
1. Check plot - no insecticide treatment.
2. Lead arsenate, 4 lb., 7 covers.
3. Lead arsenate, 4 lb., plus zinc sulfate, 4 oz. plus summer oil emulsion, 2 qt., 7 covers. Oil omitted after 5th cover spray.
4. Lead arsenate, 4 lb., plus "Vapotone,"1/ 1 pt., 7 covers.
5. DDT 50% wettable2/, 1 1/2 lb. plus "DN Dry Mix No. 1,"3/ 5 oz., 7 covers.
6. DDT 50% wettable, 1 1/4 lb., plus "DN-111,"4/ 1 1/4 lb. plus lead arsenate, 3 lb., 4 covers.
7. DDT 50% wettable, 1 1/2 lb. plus "DN-111," 1 lb., 5 covers.
8. DDT 50% wettable, 1 1/2 lb. plus "DN-111," 1/2 lb., 6 covers.
9. "Miticidal DDT,"5/ 5 lb., 7 covers.
10. "Black Leaf 155,"6/ 3 lb., 1st and 2nd covers; 2 lb. plus "Superla" summer oil emulsion, 2 qt., 3rd through 7th covers.
11. "Black Leaf 155-DDT"7/ 3 lb., 1st and 2nd covers; 2 lb. plus "Superla" summer oil emulsion, 2 qt., 3rd through 7th covers.
12. "Rhothane WP-50,"8/ 3/4 lb. plus "H. E. 761,"9/ 3/4 lb., 7 covers.

1/ Fifty percent hexaethyl tetraphosphate (California Spray Chem. Corp.).

2/ Deenate - 50-W (E. I. DuPont de Nemours & Co., Inc.).

3/ A concentrated dinitro compound (Dow Chemical Company).

Footnotes continued on following page.

Footnotes (Continued)

4/ A derivative of dinitro ortho cycloheylphenol (Dow Chemical Co.).

5/ DDT plus hydroxy pentamethyl flavan (E. I. DuPont de Nemours & Co., Inc.).

6/ A fixed nicotine (Tobacco By-Products Corp.).

7/ Seven percent of 100 percent soluble nicotine plus 17 percent DDT (Tobacco By-Products Corp.).

8/ Fifty percent dichloro-diphenyl-dichloroethane (Rohm & Haas Co.).

9/ 3,4-dichloro benzene sulfonitranilide-4 (Rohm & Haas Co.).

Two single-tree replicates randomized in 8 rows of trees, each row containing 10 trees, were used for each insecticide or combination of insecticides tested. Two early sulfur sprays were applied for apple scab control. Lead arsenate, 4 pounds to 100 gallons of water, was applied uniformly to all trees in all plots, except the check plot which received no insecticide sprays, in the calyx spray which was applied May 19. The cover sprays, timed in accordance with two sets of codling moth bait traps, were applied as follows: First cover, June 2; second cover, June 11; third cover, June 25; fourth cover, July 9; fifth cover, July 22; sixth cover, August 5; seventh cover, August 19.

Summer oil emulsion was omitted from the sprays used on the lead arsenate-zinc sulfate plots after the fifth cover spray. DDT was used in a varying number of sprays on four plots to determine the number of DDT sprays necessary for best control of codling moth under northeast Kansas conditions. Miticides were added to nine plots to obtain a comparison between the miticide used and between the different strengths of "DN-111." A plot receiving no insecticide or miticide was left to obtain information about the increase of codling moth, two-spotted mite, and red-banded leaf roller. Four to seven spray applications were made to the trees in all plots except the check plot.

No hormone spray applications were made to the plots to prevent the fruit from dropping.

Wormy, stung, and clean dropped apples were recorded for each tree at intervals during the summer to August 30. A hail and wind storm on September 10 caused most of the apples to drop in the orchard where the test plots were located. Five hundred dropped fruits were counted per tree September 12 through September 18 and considered as harvested apples.

Apples selected at the time of harvest from all plots were collected and analyzed for arsenic or DDT residue.

Results

Data for the various insecticide tests for the control of codling moth, two-spotted mite, and red-banded leaf roller in the Blair experiment orchard at Blair, Kansas are recorded in Tables 2, 3, and 4.

Table 2. Percentages of wormy and stung apples by codling moth during various periods and the entire season, and residue analyses, 1947.

Treatment Number	Apples dropped to August 30			Harvest Counts September 12			Summary (Entire Season)				Residue[7] (grains As_2O_3 per lb)		Residue[7] (grains DDT per lb.)	
	Total per plot	Per cent wormy	Per cent stung	Total per plot	Per cent wormy	Per cent stung	Total per plot	Per cent wormy	Per cent stung	Per cent clean	Unwashed	Washed	Unwashed	Washed
1	1140	34.0	1.1	1000	23.5	1.0	2140	29.1	1.0	69.9	--	--	--	--
2	224	4.5	0.9	1000	1.0	2.0	1224	1.6	1.8	96.6	0.141	0.014	--	--
3	206	3.9	0.5	1000	0.8	0.7	1206	1.3	0.7	98.0	0.159	0.013	--	--
4	293	2.7	0.0	1000	3.3	3.3	1293	3.2	2.5	94.3	0.116	0.014	--	--
5	176	2.3	0.0	1000	1.8	0.6	1176	1.9	0.5	97.6	--	--	0.013	0.013
6	160	5.6	0.0	1000	15.8	1.2	1160	14.4	1.0	84.6	--	--	0.078	0.073
7	105	0.0	0.0	1000	9.9	2.1	1105	9.0	1.9	89.1	--	--	0.007	0.010
8	172	1.2	0.6	1000	7.7	0.7	1172	6.7	0.7	92.6	--	--	0.010	0.016
9	218	0.5	0.0	1000	1.6	0.9	1218	1.4	0.7	97.9	--	--	0.031	0.023
10	204	10.8	0.0	1000	0.7	0.2	1204	2.4	0.2	97.4	--	--	--	--
11	399	2.8	0.0	1000	1.2	0.8	1399	1.6	0.6	97.8	--	--	0.077	0.054
12	221	12.7	0.4	1000	3.7	1.4	1221	5.3	1.2	93.5	--	--	0.043*	0.042*

[7] Residue analyses were made by Dr. A. T. Perkins, Analytical Chemical Laboratory, Kansas Agricultural Experiment Station.

*Grains DDD per pound.

Table 3. Two-spotted mite counts per numbers of leaves from each plot, Blair, Kansas, June 14 to September 15, 1947

Treatment	100 leaves		25 leaves						10 leaves						Leaf drop and condition of leaves	
	June 14		July 15		August 1		August 7		August 14		August 30		September 15		September 15 to October 5	October 6 to October 22[8]
	Mites	Eggs	Mites	Eggs	Mites	Eggs	Mites	Eggs	Mites	Eggs	Mites	Eggs	Mites	Eggs		
1	1	0	119	71	439	1214	1700	2175	Not Counted		Not Counted		Not Counted		40% of foliage dropped Foliage bronze in color	95% of foliage dropped New leaves and many blossoms
2	0	0	0	0	23	16	118	81	163	565	1813	2300	Not Counted		30% of foliage dropped Foliage bronze in color	90% of foliage dropped New leaves
3	0	0	0	0	7	25	3	2	21	81	274	504	Not Counted		10% of foliage dropped Foliage bronze in color	50% of foliage dropped Foliage bronze in color
4	0	0	0	0	1	4	5	1	41	55	248	1167	Not Counted		10% of foliage dropped Foliage bronze in color	95% of foliage dropped New leaves and many blossoms
5	0	0	0	0	0	0	0	0	0	0	0	0	21	24	No foliage loss Foliage dark green color	Foliage excellent Foliage dark green color
6	0	0	0	0	0	0	0	0	6	23	156	466	Not Counted		5% of foliage dropped Foliage light green color	50% of foliage dropped Foliage bronzed
7	0	0	0	0	0	0	0	0	0	0	35	74	110	139	No foliage drop Foliage dark green color	5% of foliage dropped Foliage pale green color
8	0	0	0	0	0	0	0	0	0	0	0	0	60	51	No foliage drop Foliage dark green color	Foliage excellent Dark green color
9	0	0	0	0	0	0	0	0	0	0	3	21	31	44	No foliage drop Foliage dark green color	Foliage excellent Dark green color
10	0	0	0	0	2	1	3	43	7	20	176	309	Not Counted		5% of foliage dropped Foliage light green color	20% loss of leaves Foliage bronze color
11	0	0	0	0	2	8	4	10	16	82	193	609	Not Counted		8% of foliage dropped Foliage light bronze color	80% loss of leaves Foliage bronze color
12	0	0	0	0	4	17	5	18	12	32	201	672	Not Counted		5% of foliage dropped Foliage light bronze color	70% loss of leaves Foliage bronze color

[8] Fall rains started October 3.

Table 4. Number and percentage of apples injured by red-banded leafroller in the codling moth control plots, Blair, Kansas, 1947.

Insecticide treatment in pounds per 100 gallons of water	Total Number Per plot	Number Injured	Per cent of Injury
1. Check plot - no insecticide treatment	2140	34	1.6
2 Lead arsenate, 4 lbs., 7 covers	1224	0	0
3. Lead arsenate, 4 lbs. plus zinc sulfate, 4 oz. plus summer oil emulsion, 2 qts., oil omitted after 5th cover, 7 covers	1206	0	0
4. Lead arsenate, 4 lbs. plus "Vapotone", 1 pt., 7 covers.	1293	0	0
5. DDT 50%, wettable, 1½ lbs. plus "DN Dry Mix No. 1", 5 oz., 7 covers	1176	0	0
6. DDT 50%, wettable, 1 1/4 lbs. plus "DN-111", 1 1/4 lb. plus lead arsenate, 3 lbs., 4 covers	1160	0	0
7. DDT 50%, wettable, 1½ lbs. plus "DN-111", 1 lb., 5 covers.	1105	3	0.3
8. DDT 50%, wettable, 1½ lbs. plus "DN-111", ½ lb., 6 covers.	1172	4	0.3
9. "Miticidal DDT", 5 lbs., 7 covers	1218	3	0.2
10. "Black Leaf 155", 3 lbs., 1st & 2nd covers; 2 lbs. plus "Superla" summer oil emulsion, 2 qts., 3rd through 7th covers.	1204	3	0.2
11. "Black Leaf 155-DDT" (7% of 100% nicotine and 17% DDT), 3 lbs., 1st & 2nd covers; 2 lbs. plus "Superla" summer oil emulsion, 2 qts., 3rd through 7th covers.	1399	0	0
12. "Rhothane WP-50", 3/4 lb. plus "H. E. 761", 3/4 lb., 7 covers.	1221	0	0

Discussion

Nine of the twelve insecticide combinations in control plots (Table 2) gave excellent codling moth control with 92.6 to 98.0 percent of clean fruit per plot for the entire season.

An increase of approximately 5 percent in clean harvested fruit resulted with each additional DDT spray applied after the fourth cover spray through the seventh cover spray. DDT used alone or in combination with other materials in four or five cover sprays was less effective in controlling codling moth than other insecticides or combinations of insecticides used in six or seven cover sprays. DDT sprays applied to all trees in the orchard not included in the plots probably aided the effective control of codling moth by lead arsenate in those plot tests.

Spray injury was apparent in the "Black Leaf 155-DDT" plus summer oil emulsion plot as early as July 15. This injury appeared first as yellowish-green areas in the leaves, followed by browning of the areas, and finally by defoliation, as was the case in 1946.

Trees in the plot treated with lead arsenate only showed some arsenical injury to the leaves by August 1. Injury to the leaves after August 7 was intensified by the presence of two-spotted mites.

Residue analyses of washed and unwashed apples indicated that the acid wash used to remove arsenic residue from fruit removed little if any of the DDT residue. All samples of fruit from trees treated with lead arsenate when washed had a residue below the residue tolerance for arsenic.

Favorable weather conditions for rapid mite development occurred during much of July and throughout August and September. The two-spotted mite caused 50 to 95 percent defoliation of trees by harvest time, where mite control was inadequate. Rains starting October 3 caused new leaf growth and blossoming in many instances. Where use of summer oil emulsion or "DN-111" was terminated during the early summer, mites became abundant, three to five weeks later.

The comparative abundance of the two-spotted mites from June 14 to September 15 on trees in the Blair experimental orchard plots is shown and its effect on the condition of the foliage is indicated in Table 3. The lead arsenate combination with 2 quarts of summer oil emulsion to 100 gallons of water, when the oil was omitted after the fifth cover spray, failed to give mite control three weeks after this application. Where miticides were added to the spray program to control two-spotted

mites and were terminated early in the spray program, the mite population increase followed three to five weeks later. The residual effect of "DN-111" for two-spotted mite control is approximately twice that of summer oil emulsion when used in the same number of sprays. Five pounds "Miticidal DDT" to 100 gallons of water and DDT plus 5 ounces "DN-Dry Mix No. 1" to 100 gallons when used in seven cover sprays and 1/2 to 1 pound "DN-111" to 100 gallons when used in five or more cover sprays inhibited proportionately the increase of two-spotted mites and foliage remained in good condition to the end of the season. Two-spotted mites were found on the trees in the "Rhothane WP-50" plus "H.E. 761" and fixed nicotine plots on August 1. The mite population in these plots did not increase rapidly until after the seventh cover spray was applied August 19. Hexaethyl tetraphosphate, when used in the regular lead arsenate spray schedule and in seven cover sprays, was not effective as a residual miticide. Defoliation of the trees by two-spotted mites in these plots by October 22 was 95 percent.

No damage by red-banded leaf roller occurred in any of the plots (Table 4) where lead arsenate was used. Apples injured by this pest were found in plots sprayed with fixed nicotine or DDT.

MASSACHUSETTS

A. I. Bourne, Massachusetts Agricultural Experiment Station, Amherst.

Tests of Lead Arsenate and DDT in Codling Moth Control

In a block of McIntosh in the Station Orchard, an all lead arsenate program in the standard schedule in pink, calyx and four cover sprays, in which the dosage was 3 pounds per 100 gallons in pink and third cover; 4 pounds in calyx, first and second covers; and 2 pounds in fourth cover spray, the record of fruit at harvest, showed 11.6 percent injury by codling moth, slight curculio scarring and 10 percent scab. Unsprayed checks in this block scored 34 percent codling moth damage and 80 percent scab.

In plots in which an emergency spray of lead arsenate 3 pounds was applied midway between second and third cover sprays (about June 21) codling moth injury was reduced to 1.2 percent and scab to 4 percent with 94 percent clean fruit.

The fungicide in this block was a combination of Fermate 1/2 pound and wettable sulfur 1/2 dosage. This proved compatible with lead arsenate and proved to be a good working combination.

Owing to the severe frost damage in part of this block, tests with a DDT and lead arsenate schedule had to be transferred to a different part of the orchard.

DDT was used at strengths of 1/2 pound, 1 pound and 2 pounds (actual) combined with lead arsenate at 2 pounds dosage.

The standard schedule in this block was followed in pre-blossom applications. The DDT combinations were applied in calyx, first, second and fourth cover sprays. Lead arsenate (3 pounds) was used without DDT in the third cover spray, aimed primarily for apple maggot control. The record of McIntosh at harvest showed almost complete control of codling moth even following 1/2 pound (actual) DDT. Damage being not over 1.1 percent in all cases.

The DDT schedule gave a degree of protection much higher than the standard lead arsenate schedule and comparable to the standard schedule with the emergency application between second and third cover sprays with the saving in cost of the extra spray. The DDT and lead arsenate combination at strengths of 1 pound and 2 pounds of DDT (actual) also held curculio satisfactorily. DDT at 1/2 pound (actual) and lead arsenate 2 pounds per 100 gallons did not give protection equal to lead arsenate (4 pounds) alone, against curculio.

MICHIGAN

Ray Hutson, Michigan State College, East Lansing.

1947 Work on the Control of Codling Moth and Associated Pests in Michigan

In the Palmer Orchards at Leslie, Michigan, a randomized block lay-out, using 21 single tree replicates for each of 7 treatments, was set up. It included Cortland, Snow and Jonathan varieties of apples. Standard spray treatments of lead arsenate and wettable sulfur were applied by the owner of the orchard through the first cover spray. Beginning with the second cover spray on June 27, experimental sprays of parathion, DDT and lead arsenate were applied. Four applications were made, following a 2-week schedule. In the first two applications, wettable sulfur was added to each treatment. No fungicide was used in the last 2 applications. Maximum temperatures on the dates of application ranged from 73 degrees to 95 degrees F. The highest temperature at which parathion was used was 86 degrees F. Treatments were applied with standard orchard equipment and all spraying was done from the ground. At harvest time the yield of each tree was recorded and 2 bushels of fruit from each tree were scored for insect injury. In a few cases, where the yield was less than two bushels, the entire yield was scored.

Treatments and results, in terms of percent of apples entered by codling moth larvae, are tabulated below. Each figure represents the average of 21 single tree plots.

Treatment	Percent of Apples Entered by Codling Moth 1/
2.5 lb. of 25% parathion	0.4
4 lb. of 15% parathion	0.6
1.75 lb. of 15% parathion	0.8
1 lb. of 25% parathion	0.9
1.5 lb. of 50% DDT	0.9
3 lb. lead arsenate, 1 lb. zinc sulfate and 4 lb. lime	2.4
Check (no insecticide after first cover)	6.2

1/ At odds of 19 to 1, the significant difference between treatment means is 1.3 percent.

None of the treatments had any significant effect on yield and no spray injury was observed. Chemical analyses by Dr. P. R. Averell of the American Cyanamid Company indicated that within three weeks after the fourth application of parathion, the residue on the fruit had decreased to less than 0.2 p.p.m.

The following items were reported by members of this department at the 1947 meeting of the American Association of Economic Entomologists in Chicago:

(1) Parathion at the concentrations mentioned above gave excellent control of the red-banded leaf roller, although not significantly better than lead arsenate. DDT gave inferior control.

(2) One application of 2.5 pounds of 25 percent parathion controlled two-spotted mite on apples, the residue remaining toxic long enough to prevent reinfestation by eggs present at the time of spraying.

(3) In trials against the European red mite, one application of 2.5 pounds of 25 percent parathion killed all live forms but did not prevent eggs from hatching and developing to maturity.

MISSOURI

Lee Jenkins, Curtis W. Wingo and Wilbur R. Enns, Missouri Agricultural Experiment Station, Columbia.

Codling Moth Control Work in Missouri - 1947

The experimental work for fruit insect control was done in three different orchards during 1947. Sixteen 3 to 4 tree plots were located at the Gardner Orchard, McBaine, Missouri. Tests in cooperation with the Fruit Experiment Station at Campbell were conducted on the control of codling moth, European red mite and two-spotted mite. The small Horticulture Orchard at Columbia, consisting of about an acre, was sprayed on a seven day schedule using 2 pounds of 50 percent wettable DDT per 100 gallons through the period of the first brood of codling moth. The last spray was applied July 7.

Gardner Orchard

The calyx and first cover sprays were the same in all plots.

Calyx - Two pounds lead arsenate plus 3/4 pound Fermate plus 3 pounds microfine sulfur.

1st cover - Lead arsenate 3 pounds plus 3/4 pound Fermate plus 3 pounds of sulfur on all plots.

Plot 1 - Second cover, 2 pounds lead arsenate, 3/4 pound 50 percent DDT plus 3 pounds sulfur and 3/4 pound Fermate; 3rd cover, insecticide same as 2nd cover, 1 pound safe-n-lead added and 4 pounds mike sulfur; 4th and 5th covers same as 3rd except fungicide omitted; 6th cover, 2 pound 50 percent 7th & 8th cover, 1 1/2 pound 50 percent DDT.

Plot 2 - Same as plot 1 except 1 pound sulfur added in 4th, 5th and 6th sprays.

Plot 3 - Second cover, 2 pounds 50 percent DDT plus 3 pounds mike sulfur plus 3/4 pound Fermate; 3rd cover same as 2nd except 4 pounds mike sulfur used as the fungicide; 4th, 5th and 6th covers, 2 pounds 50 percent DDT.

Plot 4 - Same as plot 1 except Methoxy DDT substituted for DDT.

Plot 5 - Same as plot 3 except Methoxy DDT and half DDT used instead of DDT alone.

Plot 6 - Same as plot 3 except half Methoxy DDT and half 3959 used (4 pounds of 25 percent 3959 is regular strength or full strength).

Plot 7 - Same as plot 3 except Methoxy DDT substituted for DDT.

Plot 8 - Three pounds lead arsenate plus 3/4 pound Fermate plus 3 pounds sulfur in 2nd cover; 3 pounds lead arsenate plus 4 pounds mike sulfur and 1 pound safe-n-lead in 3rd cover; 4th cover, 3 pounds lead arsenate plus 1 pound safe-n-lead; 5th, 6th and 7th covers 3 pounds Tobacco By-Products nicotine and DDT blend plus 1/2 gallon oil; 8th cover 2 pounds 14 percent 155 plus 1 quart oil.

Plot 9 - Second, 3rd and 4th covers same as plot 8; 5th, 6th and 7th covers 2 pounds 14 percent 155 plus 2 quarts summer oil; 8th cover 2 pounds 14 percent 155 plus 1 quart oil.

Plot 10 - DDT as in plot 3 plus 3 pounds HS sticker. Sticker omitted in 4th cover.

Plot 11 - Second cover 2 pounds HE-761 plus 1 pound WP-50 and 3/4 pound Fermate and 3 pounds sulfur; 3rd cover same as 1st except 4 pounds sulfur used and Fermate omitted; 4th cover same as 3rd cover except no fungicide used; 5th cover same as 4th cover; 6th and 7th covers 2 pounds 50 percent DDT; 8th cover 1 1/2 pounds 50 percent DDT.

Plot 12 - Second cover 4 pounds HE-761 plus 3/4 pound Fermate plus 3 pounds mike sulfur; 3rd cover 4 pounds HE-761 plus 4 pounds mike sulfur; 4th, 5th and 6th covers 4 pounds HE-761; 7th and 8th covers same as plot 11.

Plot 13 - Same as plot 8 in 2nd, 3rd and 4th covers; 5th and 6th covers 3/4 percent non-pareil; 7th cover, trees 45, 50, 58, 1 1/2 pounds 50 percent DDT, tree 53, 3 quarts non-pareil; 8th cover all trees sprayed 1 1/2 pounds 50 percent DDT.

Plot 14 - Second cover 1 pound 50 percent DDT plus 1 pound 50 percent chlordane plus fungicide as in plot 1; 3rd cover 1 pound 50 percent chlordane plus 1 pound 50 percent DDT plus fungicide as in plot 1; 4th, 5th and 6th covers 1 pound 50 percent chlordane plus 1 pound 50 percent DDT; 7th and 8th 3/4 pound each of DDT and chlordane.

Plot 15 - Same as plot 3 except 4 pounds 3956 at 4 pounds per 100 gallons substituted for DDT.

Plot 16 - Three pounds lead arsenate plus 4 pounds brown sugar plus 3/4 pound Fermate and 3 pounds mike sulfur in 2nd cover; 3rd, 4th, 5th, 6th, 7th and 8th covers 3 pounds lead arsenate plus 4 pounds brown sugar. The 3rd cover only having 4 pounds mike sulfur added. One pound safe-n-lead added to each spray.

Results at the Gardner Orchard in 1947

Plot No.	% Wormy	% Stung	% Clean
1	3.6	.7	95.7
2	8.2	1.0	90.7
3	7.8	.5	90.7
4	12.4	1.5	86.1
5	4.7	.3	95.0
6	6.4	.4	93.2
7	15.6	.7	83.7
8	6.5	.3	93.2
9	13.5	2.0	84.5
10	8.8	1.6	89.6
11	5.0	.4	94.6
12	14.0	1.4	84.6
13	2.4	.4	97.7 (Tree No. 53)
14	7.5	1.0	91.5
15	69.7	.0	30.3
16	3.2	2.6	94.2

Horticulture Orchard at Columbia

Date	Host	No. Apples Examined	No. Worms Found
Sept. 9	2 Golden Delicious	500	0
Sept. 9	1 Jonathan	250	1
Oct. 1	1 Staymen	200	3

Red Mite, Red Spider and Codling Moth, Campbell, Missouri - 1947

This was a combination red spider, European red mite and codling moth study. The experiment was designed to test the efficiency of various acaricides, when used throughout the season as "suppressives" for red spider and European red mite. At the same time notes were to be made of the effects of these acaricides on the insecticides used for codling moth control. The materials were applied with the regular codling moth cover sprays.

Six plots in the variety Red Delicious were used. The spray program was as follows beginning in the fourth cover.

Plot 1 - Two pounds lead arsenate, 1 pound safe-n-lead, 3/4 pound (50 percent) DDT, 1 pound mike sulfur in 4th cover; 2 pounds DDT (50 percent), 1 pound mike sulfur in 5th, 6th, 7th and 8th covers.

Plot 2 - Two pounds lead arsenate, 1 pound safe-n-lead, 3/4 pound (50 percent) DDT in 4th cover; 2 pounds DDT (50 percent) in 5th, 6th, 7th and 8th covers.

Plot 3 - Two pounds DDT, 1 pound safe-n-lead, 4 pounds Flavan in 4th and 5th covers; 1 pound, 3 ounces (50 percent) DDT plus 5 pounds DDT-Flavan mixture in 6th, 7th and 8th covers.

Plot 4 - Two pounds lead arsenate, 1 pound safe-n-lead, 2 pounds DDT-Genicide mixture in 4th cover; 2 pounds DDT-Genicide mixture in 5th, 6th and 7th covers; 1 1/2 pounds DDT-Genicide mixture in 8th cover.

Plot 5 - Two pounds lead arsenate, 3/4 pound (50 percent) DDT, 5 ounces DN-111 in 4th cover; 2 pounds (50 percent) DDT plus 5 ounces DN-111 in 5th, 6th, 7th and 8th covers.

Plot 6 - Two pounds lead arsenate, 1 pound safe-n-lead, 2 pounds (50 percent) DDT and 1 pound mike sulfur in 4th cover; 2 pounds (50 percent) DDT plus 1 pound mike sulfur in 5th cover; 2 pounds (50 percent) DDT in 6th, 7th and 8th covers.

Periodic leaf counts were made for mite and spider development and pre-harvest counts were made for codling moth control. The following table contains the results of all counts.

Red Mite,1/ Red Spider1/ and Codling Moth - Campbell, Missouri, 1947
Variety - Red Delicious

Plot	June 24		July 21		July 21		September 9		
	Eur. Red Mite per Leaf		Eur. Red Mite per Leaf		Red Spider per Leaf		Codling Moth Control		
	Eggs	Mites	Eggs	Mites	Eggs	Spiders	% Wormy	% Stung	% Clean
1	0.3	0.6	42.8	38.0	0.06	4.0	4.8	2.0	93.2
2	0.2	0.0	31.6	25.4	0.0	0.0	7.6	2.8	89.6
3	0.2	0.2	44.2	15.4	0.0	3.0	8.8	4.0	87.2
4	0.0	0.2	6.6	1.6	2.2	7.2	4.8	3.6	91.6
5	19.4	10.9	77.7	74.3	0.0	0.5	21.6	3.6	74.8
6	44.1	19.5	--	--	--	--	11.6	2.4	86.0

1/ All plots checked June 9 before any acaricides were applied--all average less than one mite and no eggs per leaf. No red spiders any plot.

MONTANA

Charles R. Hunt, Montana Agricultural Experiment Station, Horticultural Branch Station, Corvallis.

Inasmuch as entomological investigations in western Montana are just being organized, there will be little to report this year on codling moth control.

Limited tests were conducted this past season on the use of DDT for codling moth control, these tests being more of a demonstrational nature. Examinations made during the course of the summer indicated, however, that woolly aphis would be a problem as build-ups of aphis populations were noted in excess of those found in the standard lead arsenate plots. Thus far, populations of red mite, etc., have not been noted in this area, although a mite very similar to the rust mite, Phyllocoptes schlechtendali Nalepa, is present on apples and is causing damage to cherries.

NEW JERSEY

B. F. Diggers and L. G. Merrill, Jr., New Jersey Agricultural Experiment Station, New Brunswick.

Codling Moth and Red Mite on Apples

Experimental work was carried out in southern New Jersey to find the relative efficiency of DDT alone and with various acaricidal materials. Thiophos 3422 Parathion (American Cyanamid Company) alone and at half strength with DDT and standard lead arsenate fixed nicotine non-wash schedule for the control of codling moth and red mite.

Plots consisted of two adjacent continuous rows of 5 Delicious and 3 Rome trees yielding 16 trees per treatment. Prior to the experimental spraying which began at the second cover spray these standard applications were made: Dormant of Elgetol for aphids, delayed dormant of 3 percent oil for red mite, pre-pink of lime sulfur for scab, petal fall of lead arsenate, lime and sulfur and first cover of lead arsenate, lime and sulfur May 19.

Table 1. Codling moth and mite control plots on Delicious and Romes.

Plot No.	Treatment in Materials per 100 Gallons
1	Genitox 50% DDT 2 lb., Dow C-714 1 qt.
2	Genitox 50% DDT 2 lb., Dow C-726 2 lb.
3	*Lead arsenate 3 lb., hydrated lime 3 lb., 83% summer oil, 1 gal., nicotine sulfate 1 pt.
4	Genitox 50% DDT 2 lb.
5	Genitox 50% DDT 2 lb., DN-111 1 1/4 lb.
6	Genitox 50% DDT 2 lb., Genicide 1 lb.
7	Genitox 50% DDT 2 lb., Thiophos 3422 1/2 lb. (25% wettable powder)
8	Thiophos 3422 1 lb. (25% wettable powder)
9	Genitox 50% DDT 2 lb., Vapotone 1 pt.
10	Genitox 50% DDT 2 lb., General Chemical 976
11	Genitox 50% DDT 2 lb., General Chemical 908
12	Unsprayed check

*For the second brood spray on July 25, the following materials were used: Black Leaf 155, 1 1/2 lb., 83% summer oil 3 qt., nicotine sulfate 1 pt.

The experimental treatments set forth in Table 1 were used in three first brood cover sprays and one second brood one. These were applied May 29, June 9, June 23-24, and July 25. No fungicidal materials were added and a light infestation of scab was present throughout the plots.

On July 15 and 16 one hundred apples per tree were examined for codling moth injury in the Rome block except in cases where a light set of fruit did not allow. Also weekly dropped apple counts were made for each tree and the consolidated records are shown in Table 2. The results of second brood spraying are also expressed in Table 2 as percent wormy drops.

Table 2. Control of Codling Moth by Various Spray Mixtures.

Plot 1/ No.	First Brood Codling Moth Injury on Romes				Control of Second Brood Codling Moth	
	No. Apples Examined	Percent Codling Moth	No. Dropped Apples	Percent Wormy	Total Drops	Percent Wormy
1	300	2.0	72	68.1	799	68.4
2	550	2.2	28	35.8	507	53.6
3	530	6.0	131	64.1	695	74.2
4	600	0.2	63	30.2	494	38.8
5	600	0.5	112	16.9	315	39.7
6	600	0.3	31	22.6	185	32.5
7	600	0.2	41	9.8	301	20.6
8	600	1.5	30	3.3	191	41.3
9	600	0.5	55	12.7	208	21.2
10	540	0.0	48	29.2	289	30.5
11	290	1.0	31	61.3	309	46.3

1/ See Table 1 for treatments.

Codling moth injury to fruit on the tree was quite low throughout except on the lead arsenate treatment. Control was very similar in other plots and difficult to distinguish any significant differences between treatments. The dropped apple counts revealed that the lead arsenate again showed less control than other treatments except for plot 1, DDT-Dow C-714, which had 68.1 percent injured drops as against 64.1 percent for lead arsenate. The Thiophos 3422 showed better control than other treatments with only 3.3 percent wormy drops. Data for codling moth on Delicious were not taken due to a very light set of fruit.

Again, against the second brood, the non-wash schedule on plot 3 and the DDT-Dow C-714 plot 1 were lowest in control, showing 74.2 percent and 68.4 percent worms. DDT-Vapotone and DDT-3422 were most efficient in control. It is interesting that whereas three first brood applications of Thiophos 3422 alone at one pound showed relatively higher control as evidenced by the drop counts, the single second brood application did not hold codling moth as well as DDT and certain acaricidal materials and DDT-3422. A possibility of more rapid weathering of Thiophos 3422 than DDT asserts itself here, probably due to greater volatility of Thiophos 3422. Heavy delayed arsenical injury showed up on plot 3 in August.

European Red Mite Control

The serious increase of red mite populations following DDT has suggested that the inclusion of acaricidal materials in cover sprays might be feasible to prevent or depress mite build-up. Tests were so designed to find the relative effectiveness of the various acaricides with DDT, of the Thiophos 3422, of the standard non-wash schedule and of the straight DDT treatment as compared against an unsprayed check. Hence under treatments described in Table 1, weekly determinations of red mite populations were made and recorded in Table 3 following.

Table 3. Mite control of Delicious under various spray treatments.

Treatment	Number Mites per 100 Leaves on:													
		June				July				August				
	5/28	9	19	23	30	7	14	21	25	5	12	18	25	9/4
DDT+Dow 714	3	5	3	5	28	81	208	556	967	2380	3110	1220	430	20
DDT+Dow 726	0	0	0	0	0	2	3	110	123	1070	1540	1140	910	210
Lead Arsenate, Oil, Nicotine	0	0	0	0	0	2	10	105	147	300	740	550	730	100
DDT alone	2	0	5	6	101	205	735	1698	2441	5740	2530	200	50	60
DDT + 1¼# DN-111	3	0	0	0	0	0	3	113	185	1445	510	1390	270	360
DDT + 1# Genicide	2	0	0	5	0	10	8	103	140	620	630	2320	1940	570
DDT + ½# Thiophos 3422	2	0	0	0	0	0	0	0	7	50	110	370	1170	1250
1# Thiophos 3422	2	0	0	0	0	0	0	0	0	15	30	110	300	540
DDT + 1 pt. HETP	0	0	0	0	0	2	0	0	3	30	70	280	1120	1840
DDT + Gen. Ch. 957	0	0	0	0	0	0	0	8	4	65	60	410	770	1000
DDT + Gen. Ch. 908	0	0	0	0	0	0	0	13	4	85	50	170	670	890
Check (No Spray)	0	0	0	0	21	10	253	328	542	1055	1630	240	0	0

The effect of the delayed dormant oil was possibly demonstrated by a suppression of mite build-up of approximately 4 to 6 weeks from the 1946 data. As expected the straight DDT plot built up a large population most rapidly and the foliage was severely bronzed and mites rapidly disappeared. The mite populations of the unsprayed check plot and the DDT-Dow C-714 showed similar curves though neither reached as high a peak as quickly nor experienced as severe bronzing.

DDT-Dow C-726 and the two standard materials, DN-111 and particularly DDT-Genicide built up considerable populations in August following incomplete control in July. The following treatments exhibited excellent control when included in each of the cover sprays until 10-20 days following the final cover spray: Thiophos 3422, DDT-Thiophos 3422, DDT-General Chemical 976, DDT-General Chemical 908, and DDT-Vapotone. That the lead arsenate-fixed nicotine non-wash schedule was an efficient mite control program is apparent. Delayed arsenical injury in August might have some effect here, however, plot 3 in the Romes which had no noticeable arsenical burning followed a similar population curve giving more weight to good control by the arsenical schedule.

Midsummer Tests of Promising Mite Control Materials

In order to further study the efficiency of the materials available a series of 11 plots of nearly equal mite populations was organized. Each plot consisted of 2 Stayman and 1 Winter Banana tree. These trees had already established populations of mites but had not proceeded to the stage of bronzing. Table 4 shows materials tested and the ratio of the mites before spraying to the total number of mites counted in five countings after spraying.

Table 4. Treatments for European Red Mite on Stayman Apple Trees.

Plot No.	Treatment in Materials per 100 Gallons	Ratio: Mites After Spray / Mites Before Spray
1	Dow C-726, 2 pounds	1.4
2	General Chemical 863	1.7
3	Thiophos 3422, 1 pound	0.7
4	General Chemical 908	1.4
5	Dow DN-111, 1 1/4 pounds	1.2
6	Genicide, 1 1/4 pounds	1.8
7	Vapotone, 1 pint	3.1
8	General Chemical 957	2.9
9	Unsprayed Check	4.5
10	Dow C-714, 1 quart	1.3
11	Summer Oil, 5 quarts	1.2

On the basis of comparative populations before spraying and after spraying for 3 weeks, Thiophos 3422 gave best control of red mite. Closely grouped in effectiveness were DN-111, summer oil, Dow C-714, Dow C-746, and General Chemical 908. General Chemical 863 and Genicide gave some control whereas Vapotone and General Chemical 957 gave no lasting control of mites. Vapotone showed an immediate reduction of mites but the populations quickly resumed a high figure. The unsprayed check developed a much greater population than any treatment. In no case, however, did a single application result in a complete or permanent control of mites where a population had been allowed to develop.

Further Testing of New Materials for Codling Moth and Red Mite in Central New Jersey

Two formulations of Thiophos 3422 were compared with each other and with a lead arsenate treatment on Rome apple trees in an orchard near Cranbury, N. J. The spray dates were as follows: First brood covers 6/2, 6/12, 6/19-20 and second brood cover 7/31, 8/2.

The treatments and results in codling moth and mite control are given in Tables 5 and 6, respectively, and data on the weathering of Thiophos 3422 residues are given in Table 7.

Table 5. Codling Moth Control on Rome Apples at Cranbury, N. J.

Plot	Treatments[1]	Worms per Tree[2]	Harvested Apples % Wormy	% Stung	% Clean
A	1 3/4# Thiophos 3422 15% wettable powder	51	2.7	6.3	91.0
B	4# Thiophos 3422 15% wettable powder	16	3.0	5.6	91.5
C	1# Thiophos 3422 25% wettable powder	61	3.3	10.7	86.1
D	2 1/2# Thiophos 3422 25% wettable powder	26	3.6	6.1	90.2
E	3# Lead arsenate (first brood); 3# Lead arsenate + 4 qt. 83% oil on 8/1.	135	6.7	8.3	84.9
F	Same as E (first brood); 1# Genicide + 3# 50% DDT on 7/31.	181	3.0	19.1	77.9
G	Same as E (first brood); 3# 50% DDT + 1 1/4# DN-111 on 8/2.	133	9.0	15.0	76.1

1/ Sulfur used as fungicide in all treatments except last spray in plots E and F.

2/ Figures are total of wormy picked fruit and drops collected.

Table 6. Mite Control on Rome Apples at Cranbury, N. J.

Plot	Treatment 1/	Mites per 100 Leaves 6/19	7/11	7/18	7/26	8/8	8/15	8/22	8/29	9/15
A	1 3/4# Thiophos 3422 15% wettable powder	0	29	68	588	0	116	84	322	1144
B	4# Thiophos 3422 15% wettable powder	0	59	44	596	0	32	20	68	1596
C	1# Thiophos 3422 25% wettable powder	0	26	60	560	0	77	44	284	1148
D	2 1/2# Thiophos 3422 25% wettable powder	0	16	60	800	0	36	16	348	1472
E	3# Lead arsenate (1st brood); 3# Lead arsenate + 4 qt. 83% oil on 8/1	-	124	616	2720	23	1272	626	1620	770
F	Same as E (1st brood); 1# Genicide + 3# 50% DDT on 7/31.	-	-	-	--	807	1780	732	3242	1300
G	Same as E (1st brood); 3# 50% DDT + 1 1/4# DN-111 on 8/2	-	-	-	--	0	228	148	408	428

1/ Sulfur used as fungicide in all treatments except last spray in plots E and F.

Table 7. Thiophos 3422 Residues on Apples from Cranbury, N. J.

Date Sampled	No. of Spray Applications	Days Since Last Spray	P.P.M. Whole	Peel	Pulp
	Plot B (4 lb. 15% W.P.)				
6/19	2	8	1.2	--	-
8/1	4	0	8.0	--	-
8/6	4	5	4.3	--	-
8/28	4	27	0.48	0.47	0.0
9/15	4	45	-	0.27	0.1
	Plot D (2 1/2 lb. 25% W.P.)				
6/19	2	8	0.9	--	-
6/20	3	0	11.2	--	-
8/1	4	0	8.8	--	-
8/6	4	5	3.0	--	-
8/28	4	27	0.5	0.4	0.0
9/15	4	45	-	0.26	0.01

No differences were observed between 15 and 25 percent wettable powders if used on equal concentrations of active ingredients against the codling moth and European red mite. Both appeared to be slightly more effective than lead arsenate in first brood and DDT in second brood. Thiophos 3422 as used in codling moth control program contained mite populations at a low level until 30 days following the last application. The residue analyses seem to indicate Thiophos 3422 residues may drop after spray applications rapidly.

NEW YORK

S. W. Harman, New York Agricultural Experiment Station, Geneva.

Codling Moth

The season of 1947 was favorable for codling moth activity in the western New York fruit belt. However, the general use of DDT solved the control problem for most fruit growers. Except for a few cases due to poor spraying or omission of applications, there was very little codling moth injury.

European Red Mite

Generally speaking the red mite was not a problem to apple growers in this area. There was a small amount of spraying done late in July but the need for control practices was questioned for the reason that due to natural causes the population declined noticeably about that time. Nothing further was reported in the nature of a mite problem during the remainder of the season.

Red-Banded Leaf Roller

The big problem for apple growers in 1947 was the outbreak of the red-banded leaf roller. Apparently the omission of lead arsenate, contrary to recommendations, from the apple spray schedule by growers who went all out for DDT, was largely responsible for the trouble. In extreme cases as much as 90 percent of the fruit was damaged by the leaf roller and a considerable amount dropped before harvest. Such crops were practically a total loss.

Both experimental evidence and grower experience showed that satisfactory control was possible with lead arsenate when used to combat the first brood caterpillars during June and July. It was important that the sprays be applied to the under surface of the foliage where the caterpillars were feeding.

Attempts to control the second brood caterpillars in August with lead arsenate were not successful. "Parathion" used in August gave almost perfect control of the leaf roller as compared with 25 percent injury on lead arsenate plots, 66 percent on DDT plots and 90 percent damaged fruit on unsprayed trees.

OHIO

C. R. Cutright, Ohio Agricultural Experiment Station, Wooster.

Temperatures for May, June, and July averaged about 4° F. below normal and the season was very unfavorable for codling moth. Temperatures in August and September were above normal and during this period codling moth made some gains.

Due to the efficiency and general use of DDT in orchards with codling moth problems, the need for control experiments has greatly decreased. Therefore, the work of the 1947 season was limited to testing 14 different schedules. Results from these experimental schedules and from observations made in orchards throughout the State may be summarized in the following statements.

1. The use of DDT was very successful in codling moth control.

2. DDT used against the second brood was particularly effective. In several cases orchards using DDT in second brood sprays only had excellent control.

3. Where DDT was used against first brood with no sprays against the second, a marked increase in infestation occurred.

4. DDT, used as low as 1/2 pound actual, was fairly effective when trees were thoroughly sprayed. The general recommendation of 3/4 pound actual was satisfactory for the use of most growers.

5. Ohio is not ready to recommend less than four DDT applications for codling moth control.

6. All DDT sprayed plots and orchards developed infestations of the European red mite unless acaricides were used. Dormant oil applications generally delayed the arrival of the injurious mite populations for from 4 to 6 weeks. In some instances where entire orchards were thoroughly sprayed with oil, protection from mites was secured for the entire season.

7. Summer dinitro was widely used and generally gave good results against mites. However, in three reported instances damage to fruit and foliage followed its use. In two cases, the dinitro was combined with "Magnetic-70" sulfur paste and DDT. This spray was applied in cool weather and injury did not appear until a period of hot weather arrived. Hexaethyl tetraphosphate was used in limited quantities by growers with only fair success.

8. One Ohio orchard suffered severe losses from the red-banded leaf roller, and the insect was found in many others that were sprayed with DDT. It was also noted in a few orchards sprayed with lead arsenate.

9. Woolly apple aphis was not a problem in Ohio orchards.

10. The use of heavy DDT schedules seems to control Comstock's mealybug. This despite the fact that such spray schedules destroy practically all parasites.

For commercial purposes, DDT has solved the codling moth problem at least for the present. The problems of controlling mites and red-banded leaf roller now demand solution.

OKLAHOMA

F. E. Whitehead,1/ Oklahoma Agricultural Experiment Station, Stillwater.

Previous to 1947 only small plots in the experiment station orchard were sprayed with DDT, the balance of the orchard being sprayed with arsenate of lead. Under these conditions the DDT sprayed trees had lower codling moth infestations than surrounding trees, but the difference was not as great as reported in most areas and the control was not as good.

In 1947 the entire orchard, excepting four rows sprayed with arsenate of lead, was sprayed with various combinations containing DDT and resulted in the smallest amount of codling moth injury occurring in the orchard for years, only one plot exceeding 1 percent in number of apples entered. This occurred in spite of the fact that the amount of injury in other orchards of the area indicated that codling moth populations in 1947 were from normal to moderately severe. The amount of injury in all plots was so slight that no significant differences were obtained between plots. As a result little, if anything, was learned concerning the comparative efficiencies of the various combinations used and therefore they are not listed in this report.

In an attempt to explain the striking reversal of form exhibited by DDT in 1947 to that of previous years and the fact that previously much poorer control has been obtained in Oklahoma than in other areas, the following hypothesis was developed.

1/ Transferred to Arkansas Experiment Station in September 1947. Report prepared at the request of Dr. F. A. Fenton.

Assuming that DDT is definitely more effective in destroying adult moths than is arsenate of lead and that there is considerable migration of adult moths from tree to tree, we would anticipate that:

A. When DDT plots are surrounded by arsenate of lead plots, although a higher percentage of adults are destroyed in the DDT plots, the migration of moths into these plots from surrounding plots and the lack of or smaller migration in the opposite direction would have a tendency to equalize populations in the two plots, and the population would tend to stabilize near the level of that produced by arsenate of lead.

B. When lead plots are surrounded by DDT plots then for similar reasons populations would tend to stabilize at the level produced by DDT.

C. The smaller the central plot and the larger the surrounding plots the more nearly they would stabilize at the level of populations found in the larger plots.

D. The greater the number of moths, and the greater the number of days in which migration occurs, the more nearly equalized the two plots would become.

If A and C are correct it would be expected that in previous years when but small portions of the orchard were sprayed with DDT and the most of it with arsenate of lead, the effectiveness of the DDT would approach that of arsenate of lead. If B is correct, it would be expected that in 1947 when a small part of the orchard was sprayed with arsenate of lead and most of it with DDT the effectiveness of arsenate of lead would approach that of DDT.

If D is correct, it would be expected that the farther north the tests are conducted and the consequent smaller number of broods and moths, together with the shorter period of migration, the less the equalizing the influence of migration would become. This in turn would result in more sharp differentiations between insecticides of varying effectiveness in the more northern parts of the United States than in the southern parts.

The anticipated results under this hypothesis are so similar to the results actually obtained that it appears entirely possible that this may be the explanation of the observations made.

Should further work prove the above to be the correct explanation, it offers possibilities of further improvement in codling moth control. It suggests that DDT sprays might better be timed to coincide with peaks of moth flights rather than at peaks of egg hatching. Also there is the possibility that aerosols might be effective against adults.

Additional indications brought out by this work are:

1. One pound actual DDT per 100 gallons of water used in second cover and all succeeding sprays gives excellent control when applied over entire orchard.

2. There are indications that smaller amounts are also effective.

3. Such a spray schedule will probably bring on a serious infestation of mites.

4. DN-111 at the rate of 1 1/4 pounds per 100 gallons of water was the most successful miticide found.

5. Two years' experience using DN-111 at high temperatures indicate that under conditions existing in central Oklahoma this material may be used at temperatures up to 100° F. without serious burning.

6. The species of mite most abundant in Oklahoma orchards in August of 1947 was a species of Tetranychus new to science.

OREGON

L. G. Gentner, Southern Oregon Branch Experiment Station, Medford.

Results of Codling Moth Investigations, 1947

Moths developing from overwintering larvae had deposited an unusually large number of eggs before application of the first cover spray, because of very favorable weather conditions. As many as five eggs were counted on the foliage of a single fruit spur in commercial orchards that had been carefully sprayed the previous year. Since most of the growers had planned to use DDT in 1947, three cover sprays, about a month apart, were recommended instead of a calyx and five or six cover sprays previously recommended when either cryolite or lead arsenate had been used - 1st cover, 2 pounds 50 percent wettable DDT; 2nd cover, 1 1/2 pounds; 3rd cover, 1 pound; with the addition of 4 ounces Z-1 deposit builder.

Tests for codling moth control were carried on in a commercial Bartlett orchard, with some Bosc trees intermingled, and in the station orchard which contained Anjou, Bartlett, Bosc, Comice, and Winter Nelis varieties. The use of small replicated plots was discontinued since it was felt that large blocks were necessary to determine the full value of DDT.

Sprays were applied with a Bean portable sprayer at a pressure of 400 to 450 pounds at the pump, using two leads of hose with single spray guns having 7/64 inch openings in the discs.

In the commercial orchard each plot consisted of two rows of 24 trees each. The remainder of the orchard was sprayed by the grower with DDT according to standard recommendations. No calyx spray was applied. The first cover spray was applied May 10; second, June 12; and third, July 10. DDT was used in the form of a wettable powder containing 50 per cent actual DDT (Penco WB50, Pennsylvania Salt Mfg. Co.). Materials used--Plot 1 - 1st cover, 1 lb. actual DDT, 4 ozs. Z-1 deposit builder; 2nd cover, 3/4 lb. DDT, 1/3 lb. Z-1, 3/4 lb. DN-111; 3rd cover, ½ lb. DDT, 1/3 lb. Z-1, 3/4 lb. DN-111; Plot 2 - 1st cover, ½ lb. DDT, 4 ozs. Z-1; 2nd and 3rd covers each ½ lb. DDT, 1/3 lb. Z-1, 3/4 lb. DN-111; Plot 3 - 1st cover, ½ lb. DDT, 4 ozs. Z-1; 2nd cover, 1/3 lb. Z-1, 3/4 lb. DN-111; 3rd cover, ½ lb. DDT, 1/3 lb. Z-1, 3/4 lb. DN-111. The fruit was harvested August 7 and 8. All of the fruit from each of eight trees per plot was examined for worm injury, including drops. Results are given in Table 1.

Table 1 - Control with DDT in Commercial Orchard

Plot and Material	% Calyx Injured	% Side Injured	Total % Wormy	% Stung Fruit	% Not Injured
#1 - DDT in 3 covers; 1 lb., 3/4 lb., ½ lb. (1)	0.050	0.030	0.080	0.030	99.89
#2 - DDT in 3 covers; ½ lb., ½ lb., ½ lb.	0.015	0.015	0.030	0.030	99.94
#3 - DDT in 1 and 3; ½ lb., ½ lb.	0.015	0.030	0.045	0.045	99.91

(1) Amount of actual DDT.

There were no worm entrances into the fruit during the second brood period. In 1946 one of the lead arsenate plots had averaged 19.5% wormy fruit. The DN-111 added at the time of the second and third cover sprays effectively controlled spider mites.

In the station orchard there are two main blocks. The upland block, consisting mostly of Anjou trees, received three cover sprays of ½ pound actual DDT applied at the recommended time, with various materials added for mite control after the first cover. The trees in the Smith tract received the recommended dosages of 1 lb., 3/4 lb., and ½ lb. of actual DDT respectively, with various materials added after the first cover, for mite control, except 2 rows of each variety which were sprayed with 2 lbs. of Genicide A (Xanthone and DDT) and 1 pint of kerosene. Two trees in this block were left unsprayed during the first brood period and one during both broods, for certain studies. In this block Bartlett trees sprayed with lead arsenate averaged 35.3% wormy fruit in 1946. Two rows of Comice trees, 23 trees per row, extended north from the Smith Tract. The south 10 trees in each row received the regular DDT sprays and the north 13 trees received 5 cover sprays of natural cryolite, 3 pounds, and deposit builder. DN-111 was added to two sprays after the first cover for mite control. Fruit was harvested as follows: Anjou, August 20; Bartlett, August 8; Bosc, September 3; Comice, September 8; Winter Nelis, September 23. Results are given in Table 2.

Table 2 - Control in Station Orchard

Variety and Materials	% Calyx Injured	% Side Injured	Total % Wormy	% Stung Fruit	% Not Injured
Anjou (Smith Tract)					
DDT - K-1875 (1)	0.00	0.00	0.00	0.20	99.80
Genecide A	0.00	0.00	0.00	0.00	100.00
DDT - DN-111	0.00	0.00	0.00	0.00	100.00
Anjou (Upland)					
DDT - K-1875	0.00	0.00	0.00	0.58	99.42
DDT - DN-111	0.00	0.07	0.07	0.07	99.86
Bartlett (Smith Tract)					
DDT - K-1875	0.07	0.00	0.07	0.00	99.93
Genicide A	0.00	0.00	0.00	0.00	100.00
Bosc (Smith Tract)					
DDT - DN-111	0.00	0.00	0.00	0.00	100.00
Genicide A	0.00	0.00	0.00	0.00	100.00
Comice (Smith Tract)					
DDT - K-1875	0.00	0.60	0.60	0.00	99.40
Genicide A	0.00	0.00	0.00	0.00	100.00
DDT - DN-111	0.00	0.14	0.14	0.14	99.72
Comice (2 North Rows)					
DDT - DN-111	0.00	0.42	0.42	0.21	99.37
Nat. Cryolite - DN-111	3.00	10.00	13.00	3.70	83.30
Winter Nelis (Smith Tract)					
DDT - DN-111	0.00	0.00	0.00	0.00	100.00

(1) Para para prime dichloro diphenoxymethane, Dow. Chemical Co. used under experimental designation of S-1018 which contained 40% of K-1875.

Control by Insecticides

The control of codling moth with DDT was outstanding. Although quite a few moths developed and the weather was very favorable for oviposition, egg laying ceased as soon as the first cover spray had been applied, and moth catches in bait pans dropped to practically nothing. Young worms emerging from eggs that had been deposited before application of DDT, were killed before they could even cause a sting on the fruit. On one tagged Bartlett spur bearing three fruits, five eggs hatched, without any trace of injury showing on the fruits. In the two north rows of Comice, trees receiving 5 sprays of natural cryolite had 13% wormy fruit compared with less than $\frac{1}{3}$% on trees receiving 3 applications of DDT.

In most cases spider mites were successfully controlled by the use of effective acaricides in combination with the DDT. In apple orchards sprayed with DDT there was a decided increase in woolly apple aphids. The use of nicotine sulfate and benzene hexachloride gave satisfactory control. During the latter part of the summer Syrphid larvae almost completely exterminated the woolly aphids in many orchards.

Spray residue at harvest

In all of the schedules indicated in this report, the DDT residue on the fruit at harvest time was well below the established tolerance of 7 parts per million.

TENNESSEE

W. W. Stanley, Tennessee Agricultural Experiment Station, Knoxville.

Summary of Data on European Red Mite Sprays - 1947

Plot	Material	No. Found on 50 Leaves 13 Days After 1st Spray		No. Found on 50 Leaves 12 Days After 2nd Spray		Total for All Stages
		Nymphs	Adults	Nymphs	Adults	
1	*C-726 2 1/2-100 Dow Chem. plus 50% DDT 2-100	13	15	4	6	38
2	Thiophos 15% 3-100 Am. Cy. Co. plus 50% DDT 2-100	8	37	31	20	90
3	Killex 100 Sherwin-Williams	250	180	90	34	554
4	DN-111 1 1/4-100 Dow Chem.	170	65	70	30	335

*Forty percent K-1875 (Bis (p-chlorophenoxy) Methane)

Plots 1 and 2 used on Red Delicious trees. Sprays applied July 25 and August 8. Plots 3 and 4 applied by grower on Stayman and Red Delicious on about the same dates. No foliage injured was found. Counts made by brushing leaves into a funnel. The mites were caught in a small white vessel and counted with binoculars.

VIRGINIA

W. S. Hough, Winchester Research Laboratory, Virginia Agricultural Experiment Station, Winchester.

Owing to the light crop of fruit, codling moth injury was concentrated more than usual. The season was more favorable for codling moth activity than the two previous seasons and DDT for the first time received an extensive practical test under rather severe conditions. The results were good. Fruit in orchards sprayed through the season with lead arsenate was severely "stung," even when only a few trees received lead arsenate and the remainder was sprayed with DDT.

Mite damage was not severe in northern Virginia. Bronzing occurred in a few orchards in other parts of the State.

The red-banded leaf roller caused considerable damage in only one commercial orchard. It is possible that the general absence of fruit and the consequent reduction in spraying with DDT might have been a contributing factor.

A summary of codling moth control is given in the following table:

Amount in 100 Gallons	Live Entries %	Total Injuries %
Robinson Orchard (5 plots for each treatment indicated; fungicides used in each series: Fermate, Phygon, Puratized, Bioquin, Compound 341.) Calyx and 5th cover sprays ending July 29, 1947.		
50% DDT 1 1/2 lb.	3.25	4.32
50% DDT 1 1/2 lb., HETP[1] 1 pt.	4.35	6.68
Genicide-A 2 lb. (1,2,3 covers); 50% DDT 1 1/2 lb. and Genicide 1 1/4 lb. (4,5 covers)	4.43	6.30
50% DDT 1 1/2 lb., DN-111 1 1/4 lb.	2.81	5.09
50% DDT 1 1/2 lb., #714, 1 pt.[2] (3rd to 5th cover)	5.81	7.87
Check, unsprayed	21.05	28.59
Funkhouser Orchard (Lead 3 lb., calyx and 1st cover, all plots) 2nd to 5th covers, May 27, June 10, 24, and July 23 respectively.		
Plot		
1-8 50% DDT 1 1/2 lb. (2nd to 5th covers), and miticide (3,4,5 covers)	6.71	7.11
9-14 50% DDT 1 1/2 lb. (2nd to 5th covers), and miticide (4,5 covers)	6.34	6.74
15 50% DDT 1 1/2 lb. (2nd to 5th covers)	10.98	11.55
16 Ryania concentrate[3] 1/2 lb. (2nd to 5th covers)	9.37	10.00
Check, not sprayed after 1st cover.	92.25	92.34
Vinegar Co. Orchard (Calyx and 6 cover sprays ending August 14, 1947.)		
Lead arsenate, 3 lb.	58.50	62.50
Millers 30% liquid DDT 1 qt.[4] and fungicide (Av. of 5 plots)	15.90	19.60
#3422[5] 3 lb.	15.00	16.50
Check, not sprayed after calyx.	98.50	98.50

Genicide-A = 62.5% xanthone, 25% DDT.

1/ HETP = hexaethyl tetraphosphate.
2/ #714 = 1,1-bis(chlorophenyl) ethane.
3/ Ryania concentrate = 8 oz. is equivalent to 6 lb. of ground root.
4/ Millers 30% liquid DDT = 1 qt. contains 10.8 oz. DDT.
5/ #3422 = 15% parathion, 0,0-diethyl O-p-nitrophenyl thiophosphate.

Effect of Miticides on Codling Moth Larvae.--Combinations of the various miticides and wettable DDT were used in the laboratory as well as in the orchards. According to the laboratory data, the following miticides did not improve effectiveness of wettable DDT: 1,1 bis(dichlorophenyl) ethane, DN-111, and 40 percent di(4-chlorophenoxy) methane. Effectiveness of DDT was improved slightly by hexaethyl tetraphosphate, tetraethyl pyrophosphate, dioctyl pthalate and xanthone (Genicide). Fifteen percent parathion, 1/2 pound per 100 gallons, improved effectiveness of the DDT spray more than any other material used. Further evidence that parathion is highly toxic to codling moth larvae, at least for several days following an application was obtained in a number of tests. For example, 60 apples picked from Stayman-Winesap trees which had been sprayed seven days previously with 15 percent parathion, 3 pounds per 100 gallons, were brought to the insectary and subjected to codling moth attack (10 eggs per apple). The test was repeated the next day and the results were as follows: Parathion, 1.3 percent live entries, 13.5 percent total injuries; 30 percent DDT emulsion 1 quart per 100 gallons sprayed at the same time, and tested in a like manner, 19.5 percent live entries and 31.3 percent total injuries. Further laboratory tests in which 15 percent parathion was sprayed on apples at the rate of 1 and 3 pounds per 100 gallons of water indicated complete control on fruit suspended outdoors for 5 days before being subjected to attack of the codling moth larvae. Observations in the Stayman-Winesap orchard, however, indicated that the residue loses much of its effectiveness against the codling moth when the interval between sprays is extended to 14 days.

WASHINGTON

W. J. O'Neill and K. C. Walker, Tree Fruit Experiment Station, Wenatchee and R. L. Webster, Washington Agricultural Experiment Station, Pullman.

1. Seasonal Conditions

Early seasonal conditions favored rapid development of buds. In consequence, full bloom date for Delicious apples occurred April 20, ten days earlier than normal. Temperatures prevailing during the growing season averaged about 10 degrees lower than average and were thus not particularly favorable for codling moth and mites in the Wenatchee area.

Despite these conditions orchards with poorly executed spray programs or inferior materials suffered losses amounting to 50-70 percent of the crop from codling moth.

2. Codling Moth Control

Codling moth control studies were largely directed to finding suitable combinations of materials used with DDT for the control of mites and woolly apple aphids.

Table 1. Materials per 100 Gallons

Plot	Material	First Cover	Second Cover	Third Cover
1	DDT 1/ Selocide 2/ Spreader 3/	2 lb. 1 qt. 1/6 lb.)5/14	1 1/2 lb. 1 qt. 1/6 lb.)6/12	1 1/2 lb. 1 pt. 1/6 lb.)7/12
2	DDT Lt. Spray Oil 4/	2 lb. 1 qt.)5/14	1 1/2 lb. 2 qt.)6/12	1 1/2 lb. 2 qt.)7/12
3	DDT Lt. Spray Oil	2 lb. 1 qt.)5/14	1 1/2 lb. 1 gal.)6/12	1 1/2 lb. 1 gal.)7/12
4	DDT Lt. Spray Oil	2 lb.)5/14 --	1 1/2 lb.)6/12 --	-- 5 qt.)7/12
5	DDT Genicide 5/ Spreader	2 lb.)5/14 -- --	1 1/2 lb. 1 lb.)6/16 1/6 lb.	1 1/2 lb. 1 lb.)7/14 1/6 lb.
6	DDT DN-111 6/ AL SO4	2 lb. 1/4 lb.)5/15 --	1 1/2 lb. 1/4 lb.)6/16 1/6 lb.	1 1/2 lb. 1/3 lb.)7/14 1/6 lb.
7	DDD K-1875 7/ Spreader	2 lb. 1 lb.)5/15 1/6 lb.	1 1/2 lb. 1 lb.)6/16 1/6 lb.	1 1/2 lb. 1 lb.)7/14 1/6 lb.
8	C-3422 8/	1.75 lb.)5/17	1.75 lb.)6/16	1.75 lb.)7/14
9	DDT C-3422	2 lb. 1 lb.)5/17	1 1/2 lb. 1/2 lb.)6/16	1 1/2 lb. 1/2 lb.)7/14

1/ DDT 50% wettable powder.
2/ Selocide, a mixture of potassium and ammonium hydroxide, sulfur and selenium, McLaughlin Gormley King Co.
3/ Spreader, proprietary dry spreader 221, Colloidal Products Co.
4/ Spray Oil, 55 Vis., 92 U.R. Oil emulsion, Sherwin-Williams Co.
5/ Genicide, Xanthone, General Chemical Co.
6/ DN-111, amine salt DNOCHP, Dow Chemical Co.
7/ K-1875, p p'dichloro diphenoxy methane, Dow Chemical Co.
8/ C-3422, Thiophos-3422, "Parathion," 0,0 diethyl O-p-nitrophenyl thiophosphate (15%) American Cyanamid Co.

Table 2. Codling Moth Control

Plot	Percent Clean	Percent Wormy	Percent Stung	Worms per 100 Apples
1	99	1	-	1
2	98	1	1	1
3	95	3	2	4
4	87	11	2	19
5	97	2	1	3
6	96	3	1	4
7	95	3	2	4
8	87	11	2	17
9	98	1	1	1

3. Mite Control

The effectiveness of the respective treatments for control of mites was determined by collecting duplicate samples of 100 leaves from each plot, removing mites and eggs with a brush machine and counting aliquots under a binocular microscope.

Table 3. Periodic Mite Counts 1/

Plot		5/13-14 Sampled			5/26-6/4 Sampled			6/23-7/9 Sampled			7/19-30 Sampled			8/22-23 2/ Sampled		
		Pac.	ER	Rust	Pac.	ER	Rust	Pac.	ER	Rust	Pac.	ER	Rust	Pac.	ER	Rust
1	Mites	28	0	-	24	0	32	48	0	128	432	0	32	88	20	28
	Eggs	20	0	-	20	0	--	40	4	--	276	8	--	136	0	--
2	Mites	76	0	-	68	12	1988	444	16	1888	2190	28	2464	--	--	--
	Eggs	48	0	-	16	20	--	820	180	--	2532	192	--	--	--	--
3	Mites	56	0	-	368	28	1772	1112	108	5728	3136	132	1024	--	--	--
	Eggs	60	8	-	148	36	--	1200	1224	--	3680	496	--	--	--	--
4	Mites	56	104	-	356	104	1192	4412	232	2880	5632	176	1120	--	--	--
	Eggs	44	252	-	164	100	--	3948	1864	--	5072	1112	--	--	--	--
5	Mites	24	4	-	500	28	8424	2724	36	11808	6584	48	1056	--	--	--
	Eggs	44	0	-	84	68	--	1628	180	--	1732	72	--	--	--	--
6	Mites	36	8	-	412	84	6708	1436	488	12096	1932	324	2560			
	Eggs	48	48	-	152	360	--	840	2498	--	884	832	--	--	--	--
7	Mites	68	0	-	296	4	856	3624	20	2144	2716	16	864	--	--	--
	Eggs	88	4	-	104	8	--	1592	136	--	1576	76	--	--	--	--
8	Mites	68	4	-	68	0	116	32	0	128	20	4	128	312	12	40
	Eggs	80	28	-	4	0	--	12	4	--	16	8	--	248	32	--
9	Mites	188	412	-	100	60	2154	16	32	4158	20	8	320	1020	36	84
	Eggs	130	936	-	0	48	--	36	160	--	8	0	--	796	168	--

1/ Calculated as average per 100 leaves for Pac., Pacific Mite; E.R., European Red Mite and Rust, Apple Rust Mite.

2/ Plots 1, 8 and 9 only counted, remainder of plots so severely damaged that mites had migrated.

Discussion and Conclusions

Plot 1, DDT - Selocide afforded excellent codling moth control despite its strongly alkaline character. Excellent control of mites was also obtained, however, before this material could be used possible residue and soil toxicity problems need to be resolved together with plant injury studies. One rancher reported the loss of more than 75 percent of his crop from use of a selocide oil spray.

Plots 2, 3 and 4. Oil - DDT, caused foliage injury and failed to give satisfactory control of mites.

Plot 5. DDT - Genicide, failed to control Pacific mite in particular. Several cases of severe dormatitis occurred in Washington attributed to the use of this material.

Plot 6. DDT-DN-111, failed to control both Pacific and European red mite. The interval between sprays was possibly too long since successful control of Pacific mite has been obtained with shorter intervals between sprays.

Plot 7. DDD-K1875, failed to control mites and codling moth control was inferior to DDT plots. Severe injury to foliage was apparent from this treatment.

Plot 8. Parathion, gave excellent control of mites but codling moth control was inferior to DDT plots.

Plot 9. DDT - Parathion, gave excellent control of mites and codling moth.

On August 20 the plots were examined for woolly apple aphid infestation. Plot 8, parathion, was the only treatment in which no colonies were found. Plot 9, parathion, had a few recently established colonies. Plots 5 and 1, Genicide and Selocide respectively, had an intermediate number of both new and old colonies. Plots 2, 3 and 4, Oil - DDT and Plots 6 and 7, DN-111 and K-1875, respectively, were badly infested.

Numerous smaller plot treatments of four trees each were made for mite and woolly aphid control. Parathion was outstanding for the control of mites and woolly aphids. Benzene hexachloride gave excellent control of aphids but failed to control mites and codling moth. Hexaethyl tetraphosphate, tetraethyl phosphates, toxaphene, K-1875, methoxyanalog of DDT, DDD, rotenone and several other experimental compounds were unsatisfactory for control of mites and aphids.

DDT Residue Removal Studies, K. C. Walker

One hundred and twenty seven samples were collected from 49 different growers and 10 pear samples from 8 growers. The DDT residue was determined by stripping these fruit with toluene and analyzing the strip for total chlorine. The results are presented in the following table:

Table 1. Distribution of DDT Residue on Fruit at Harvest Time from Commercial Fruit Orchards.

Recommended Programs[1/]	DDT Residue in Parts per Million	Number of Samples	
		Apples	Pears
	0-0.9	2	1
	1-1.9	10	5
	2-2.9	29	2
	3-3.9	19	1
	4-4.9	17	1
	5-5.9	16	
	6-6.9	5	
	7-7.9	3	
	8-8.9	3	
	10-10.9	1	
	11-11.9	1	
Non-Recommended Programs			
	3-3.9	2	
	4-4.9	1	
	5-5.9	2	
	6-6.9	2	
	7-7.9	6	
	8-8.9	5	
	9-9.9	2	
	18-18.9	1	

Where the recommended spray programs were followed in commercial orchards 92.4 percent of the apple samples submitted for analysis were below the present informal tolerance. Where other than recommended spray programs were followed 33.3 percent of the apple samples submitted for analysis were below the tolerance. Of a total of 127 apple samples submitted for analysis irrespective of spray programs 82.8 percent were below the tolerance. All pear samples received were from recommended spray programs and all samples were below the tolerance.

1/ Spray programs similar to the ones recommended by the State College of Washington.

Effect of Late Season Applications of DDT, DDT-Oil Mixtures and Late Oil Sprays on DDT Residue at Harvest Time

Bartlett Pears

Spray Date	Pounds of 50 Percent DDT per 100 Gallons of Water		
	Plot 1	Plot 2	Plot 3
5-10	2	2	2
6-14	2	2	2
7-9	1.5	1.5	1.5
7-17	0.38 1/	0.38 1/	0.38 1/
8-2		2	2 1/ 2/
Residue	2.8 ppm	10.6 ppm	22.1 ppm

1/ Applied as a red spider mite spray containing 25 percent DDT.
2/ Two quarts light grade summer petroleum oil applied with DDT.
Fruit harvested 8-6-47.

Buerre D'Anjou Pears

Spray Date	Pounds of 50 Percent DDT per 100 Gallons of Water		
	Plot 1	Plot 2	Plot 3
5-10	2	2	2
6-14	2	2	2
7-9	1.5	1.5	1.5
7-17	0.38 1/	0.38 1/	0.38 1/
8-20		2	2 1/ 2/
Residue	3.2 ppm	6.7 ppm	11.7 ppm

1/ Applied as a red spider mite spray containing 25 percent DDT.
2/ Two quarts of light grade summer petroleum oil applied with DDT.
Fruit harvested 8-27-47.

Red Delicious Apples

Spray Date	Pounds of 50 Percent DDT per 100 Gallons of Water			
	Plot 1	Plot 2	Plot 3	Plot 4
5-14	2	2	2	2
6-5	1.5	1.5	1.5	1.5
7-12	1.5	1.5	1.5	1.5
7-24	0.38 1/	0.38 1/	0.38 1/	0.38 1/
8-19		2	2 1/ 2/	3 qt. 1/ 2/ 3/
Residue	9.9 ppm	7.3 ppm	12.3 ppm	5.6 ppm

1/ Applied as a red spider mite spray containing 25 percent DDT.
2/ Two quarts light grade summer petroleum oil applied with DDT.
3/ Three quarts light grade summer petroleum oil applied alone.
Fruit harvested 9-8-47.

All treatments increased the DDT residue at harvest time. All treatments, except Plot 4, Red Delicious, and Plot 2, D'Anjou Pears, made it necessary to wash the fruit for removal of DDT residue.

Red Delicious Apples

Washing Treatment	Plot 1		Plot 3		Plot 4	
	PPM	Diff. for Sign. at 5% Level	PPM	Diff. for Sign. at 5% Level	PPM	Diff. for Sign. at 5% Level
None	2.9		12.3		5.6	
Water @ 90°F.	2.6	1.4	13.9	2.8	5.0	2.8
8 1/2 lb. A.C. @ 90°F.5/			12.2	2.8	5.1	2.8
16 lb. A.C. @ 90°F.			12.1	2.8	4.9	2.8
1% HC_1 @ 90°F.			11.8	2.8	5.0	2.8
1% HC_1 + 1 gal. No. 27 per 270 gal. @ 90°F 6/			11.1	2.8	5.1	2.8
1% HC_1 + 2 gal. No. 27 per 270 gal. @ 90°F.			12.0	2.8	5.3	2.8
2 lb. Red Apple Wash per 270 gal. @ 90°F.7/			12.3	2.8	6.0	2.8
2.75 lb. No. 30 per 270 gal. @ 90°F.8/			13.4	2.8	5.1	2.8
5.25 lb. No. 30 per 270 gal. @ 90°F.			12.1	2.8	4.9	2.8
3.3% Sodium Hydroxide @ 165°F. + 3.3% Sodium Hydroxide @ 163°F.			9.6	1.4	4.4	1.4
1% FW-3 @ 61°F.	2.5	1.3				
1% FW-3 @ 90°F.	2.2	1.6				
1% FW-3 @ 100°F.	2.3	1.6				

5/ Product of Dubois Chemical Co.
6/ Product of Gamlen Chemical Co.
7/ Product of Van Waters & Rogers.
8/ Product of Gamlen Chemical Co.

None of the washing treatments significantly removed the DDT residue, except the treatment with two baths of 3.3 percent Sodium Hydroxide at 165°F. and 163°F. with a three minute immersion time on Plot 3. This treatment did not give effective residue removal on Plot 4.

CANADA (British Columbia)

J. Marshall, Dominion Entomological Laboratory, Summerland.

Investigations on Control of Codling Moth, Orchard Mites and Woolly Aphid, 1947 - Summary

Codling Moth

Trials with adhesives for DDT suggest that polyethylene polysulphide (P.E.P.S.) 1 pt.:100 gal. and sodium carboxy methyl cellulose (Carboxel) 0.5 lb.:100 gal. increase DDT deposit to a measurable degree. Experiments with "Micronized" and "Mikro-Pulverized" DDT at 0.5 lb.:100 gal. indicated no significant difference in effectiveness in 5 cover sprays. Infestation in each instance was less than 1%. Differences may appear either when the concentration or the number of applications is reduced. Chlorinated camphene ("Toxaphene") did not prove effective against codling moth. The methoxy analogue of DDT appeared as effective as DDT. Here again, reduction in concentration or in number of applications might bring out differences in effectiveness. DDT-tobacco residue mixture ("Tobacine") containing 15% DDT used at 1 pt.:100 gal. in 5 cover sprays gave effective codling moth control as did DDT 16% - hydroxypentamethyl flavan 20% ("Miticidal DDT") used at 5 lb.:100 gal. in first and second cover sprays and 3 lb.:100 gal. in third, fourth and fifth cover sprays.

European Red Mite

Field experiments conducted with 15 different organic compounds of possible value as miticides, led to the following conclusions: (1) Monoethanolamine dinitrocyclohexylphenolate 2 oz. parent compound 100 gal. appears to be the best miticide readily available for 1948. It is inexpensive; has a fairly high residual value; is more effective in hot than cool weather. This compound has been developed as a miticide in the Okanagan Valley of British Columbia over a five year period and in 1947 was used with success in a considerable number of commercial operations. (2) Hexaethyl tetraphosphate 50% ("Vapatone") 1 pt.:100 gal. had little residual effect although two sprays 10 days apart gave a moderate degree of mite control. (3) Xanthone is somewhat slow in action. At 2 lb.:100 gal. with stove oil 0.25 gal. it has been reasonably effective against European red mite and Pacific mite. Fairly extensive commercial use in British Columbia during 1947 revealed that xanthone may cause severe dermatitis in the occasional individuals who are sensitive to it. (4) Dicyclohexylamine dinitrocyclohexylphenolate 20% as 1 lb. "DN-111":100 gal. has not been sufficiently effective in cool weather. In hot weather it has seemed more effective than xanthone 2 lb. against Pacific mite, less effective against European red mite. (5) Rotenone 1%-oil (as "Visko" or "NNOR" 1 pint-summer oil 0.5 gal.) has been moderately effective against both species of mite and is indicated where pear psylla too must be combated. (6) Chlorinated camphene ("Toxaphene") as 1 pound 50% liquid

concentrate appeared to be a fairly effective miticide. In the form of 40% wettable powder 1.25 lb.:100 gal. it was not as satisfactory. (7) "Parathion" as 15% wettable powder 6 oz.:100 gal. is one of the most promising miticides yet examined. The fact that it has good residual qualities and is very toxic to various sucking insects makes it of particular interest. (8) Diparachlorophenylmethylcarbinol ("DMC") at 0.5 lb.:100 gal. likewise has been an outstanding miticide. (9) Monoethanolamine dinitrosecondarybutylphenolate, also promising, appears to be of about the same order of effectiveness as the monoethanolamine salt of dinitrocyclohexylphenol. (10) Di(4, chlorophenoxy) methane 40% ("NECTRAN", "K1875") seemed a somewhat less effective miticide than "DMC". It possesses good residual value but seems prone to cause russet of apples if applied early in the season.

The remaining compounds, (11) disodium ethylene bis dithiocarbamate ("Dithane") (12) 3,5-dinitro-O-cresol (13) ammonium dinitrocresolate (14) monoethanolamine dinitrocresolate (15) hydroxypentamethylflavan were not sufficiently toxic to European red mite at practical concentrations.

WOOLLY APHID

Of the materials applied in field trials against heavy infestations of woolly aphids the most effective were gamma hexachlorocyclohexane (BHC) 6%, 2 lb.:100 gal. with summer oil 0.5 gal. and nicotine sulphate 40% 1 pint:100 gal. with summer oil 0.5 gal. Hexaethyl tetraphosphate 50% ("HEXAPHOS") 0.5 pint: 100 gal. was less effective and rotenone 1% as "NNOR" 1 pint:100 gal. with 0.5 gal. summer oil was still less so. "Parathion" 15% 6 oz.:100 gal. was not satisfactory against woolly aphid but there are indications from trials against other aphid forms that addition of a surface-active compound such as sodium lauryl sulphate may increase its toxicity to woolly aphid.

HIGH-SPEED "AUTOMATIC" SPRAY EQUIPMENT

Satisfactory codling moth control and European red mite control were obtained with three of four different models of light, high-speed hydraulic type sprayers, the single Bean Mist-Sprayer, the double Bean Mist-Sprayer-Duster and the Buffalo Turbine Sprayer. It was found necessary to modify the machines by replacement of their low-pressure pumps with small plunger-type high pressure units and replacement of their perforated brass delivery tubes with a bank of conventional whirl-disc spray nozzles mounted on the outer edge of the "fish-tail" air vent. The per acre dosage of materials was DDT 50% wettable 16 lb., monoethanolamine dinitrocyclohexylphenolate 1 lb. (as parent compound), water 50 gal. A Besler Aerosol generator was also assessed. It gave less uniform deposits and less uniform codling moth control than the above modified hydraulic machines but it is believed that it will give better performance after modification by the addition of a suitable air blower. It gave good control of European red mite when charged with hexaethyl tetraphosphate or monoethanolamine dinitrocyclohexylphenolate concentrate. A Bell hilicopter was available for experiment rather late in the season. It gave control of Pacific mite equal to ground equipment (Bean Mist-duster) using the same miticidal dust in approximately the same amount. It gave excellent results in application of hormone spray concentrate, to delay fruit drop.

CANADA (Continued)

W. G. Garlick, T. Armstrong and W. L. Putman, Dominion Entomological Laboratory, Vineland Station, Ontario.

Temperatures for April and May were about normal; June and July appreciably below normal; August, September and October markedly above normal. Precipitation for May was nearly an inch above normal, for June two inches above, for July slightly below and for August nearly an inch lower than normal. These weather conditions greatly retarded codling moth emergence and development in the first half of the season but brought about quite serious injury later in orchards where early control was poor. In such orchards numerous fresh entries were noted on August 12.

Serious mite infestations late in the season appeared in a few orchards sprayed with and without DDT. In most of the few orchards observed, where DDT was used without an acaricide, red mite injury was not severe.

No red-banded leaf roller larvae were observed but there was a trace of what appeared to be its work in one or two orchards sprayed for the second year with DDT.

Results of Control Experiments

Orchard A

Plots - Large McIntosh, 20-tree plots (4 x 5) in duplicate. Sprayed from ground with single guns, about 20 gal. per tree. All surrounding trees in this orchard sprayed with DDT. The crop was small, only about 1/3. In 1946, when the trees were grower-sprayed, codling moth injury was so severe most of the trees were not picked. Counts were made of total crop, including drops, on three trees per plot. Spray intervals 10 days unless otherwise stated, and last spray applied July 25. DDT used was a 50% wettable spray powder. Actual DDT given in table below.

Plot	Schedule (Amounts per 100 gal. Imperial)	Total apples examined	% Clean	% Deep	% Stung
1	DDT, 5 covers, 1 lb., 1 lb., ¾ lb., ½ lb., ½ lb.	11155	95.0	3.6	1.4
2	Covers 1, 3, 5, DDT 1 lb. " 2, 4, lead 3¾ lb., lime 3¾ lb. and 1% oil	7842	96.7	1.6	1.7

Plot	Schedule (Amounts per 100 gal. Imperial)	Total apples examined	% Clean	% Deep	% Stung
3	First Cover DDT 1 lb. Covers 2,3,lead $3\frac{3}{4}$ lb., lime $7\frac{1}{2}$ lb. and 1% oil. " 4, lead $2\frac{1}{2}$ lb., lime 5 lb. and $\frac{1}{2}$% oil. " 5 cryolite $3\frac{3}{4}$ lb.	7710	86.4	8.1	5.5
4	DDT 1 lb. in five covers	7974	97.5	1.6	0.9
5	DDT 1 lb. in 3 covers, 10,15 and 17 days	7814	92.2	4.8	3.0
6	DDT 1 lb. in 1st cover Covers 2,3,4 and 5, DDT $\frac{3}{4}$ lb.	8017	94.2	4.0	1.8
7	DDT 1 lb. in 4 covers 10, 12, 14 and 15 days	8671	96.2	2.6	1.2
8	DDT 1 lb. in covers 1, 2, DDT $\frac{3}{4}$ lb., lead $2\frac{1}{2}$ lb. DN-111 $1\frac{1}{2}$ lb. in 3 and 4. DDT 1 lb. in 5.	8944	95.7	2.8	1.5
9	Same as plot 2 but grower-sprayed with Speed Sprayer (4 trees examined)	4978	86.2	4.7	9.1

Note - DDT used in first cover in all plots and applied by means of grower's Speed Sprayer.

Orchard B

Small orchard of young trees, mostly McIntosh but including Wealthy, Snow and Spy. Grower sprayed, supervised, 5 covers of DDT, 1 lb. Orchard heavily infested with codling moth for several years. Counts of five McIntosh (not including early drops) gave total fruits 8762, clean 93.3%, deep 1.4% and stings 5.3%.

Orchard C

Small orchard of mixed trees including Ontario, McIntosh, Wealthy, Jonathan and Cranberry. Grower sprayed, 5 covers of DDT 1 lb., but intervals erratic, 12, 14, 12, 14 and 11 days. Orchard heavily infested in 1946. Counts of 5 McIntosh and 5 Ontario trees, including all drops, gave total fruits 34562, clean 90.6%, deep 4.6%, stings 4.8%. European red mite injury not severe.

Orchard D

Small orchard of medium sized McIntosh and Spy, running 24% deep

(McIntosh) and 13% (Spy) injuries in 1946. Grower sprayed three covers only, DDT 1 lb., at 10, 14 and 12 days. Counts on 6 McIntosh, whole crop plus drops, gave total fruits 5457, clean 63.4%, deep 30.6%, stings 6.0%. Counts on 6 Spy trees gave total fruits 7075, clean 79.4%, deep 13.1%, stings 7.5%.

Orchard E

Small orchard continuous with D above but of younger trees of 5 varieties. Grower sprayed three covers only, DDT 1 lb. at 10, 12 and 12 days. Counts taken on 6 Delicious (red) trees, whole crop including drops, gave total fruits 4627, clean 85.6%, deep 11.3%, stings 3.1%. Infestation in 1946 for same variety ran about 9% deep.

Effect of DDT on young larvae in apples sprayed after larvae had entered.

Stored apples, with calyx and stem end waxed, and to which black-stage eggs were attached, were held in incubator at 77°F. Unhatched eggs were removed 18 hrs. later. After 48 hrs. in incubator apples were held in laboratory (approximately 68°F.) for 22 hrs., then sprayed with DDT 1 lb. per 100 gal. and returned to the incubator. A few days later the apples were carefully dissected and the following figures obtained.

	# Fruits	# Entries	Larvae Alive	Larvae Dead	Spray efficiency (Abbott)
Sprayed -	40	142	75	49	32.4%
Check -	38	152	92	11	

A second series, carried out a few days later, was essentially the same except that the fruit was sprayed 48 hrs. after placement of eggs and was held in incubator at 72°F. for five days after spraying before dissection was begun.

	# Fruits	# Entries	Larvae Alive	Larvae Dead	Spray efficiency (Abbott)
Sprayed -	24	97	37	38	35.7%
Check	27	92	46	14	

Most of the dead larvae were found near the surface and in several cases had tunnelled to or near the core beforehand.

DDT - Effect of Particle Size on newly hatched larvae

Laboratory tests on the effect of particle size on the toxicity of DDT to newly hatched codling moth larvae were run according to the procedure outlined in the 1945 Report, Part I, p. 125. Each test was run in duplicate, one lot of 10 fruits having eggs placed on them one day after spraying without further treatment, and the other being washed three times in an 'artificial rain' machine before the eggs were placed. Samples of DDT dispersable powders, 50% in clay, were supplied by E. I. du Pont de Nemours & Company through Canadian Industries Limited. Average mean particle diameter of the samples according to the suppliers were: 1. Micronized - about 5 microns. 2. Micro-pulverized (hammer milled) - about 15 microns.

In the case of unwashed deposits, results were very erratic and no conclusions can be drawn. When the sprayed fruits were washed, however, the powder of larger particle size allowed a consistently higher rate of establishment of larvae (see table.)

Establishment of Newly Hatched Codling Moth Larvae in Apples Sprayed with DDT Powders; Fruit Washed after Spraying; DDT (actual) at 0.25 lb. per 100 Imp. Gal.

Test No.	No. of replicates (10 fruits each)	Percentage establishment Micronized	Micropulverized
1	3	37.9	57.7
2	4	30.9	45.6
3	4	33.8	51.0
4	4	25.7	52.3
5	3	48.1	58.5

European Red Mite Control - Preventive Sprays

Plots consisted of 10 (2 x 5) fairly large Delicious (red) trees which received 5 covers of DDT 1 lb. The acaricides were added to the third and fourth covers which were applied July 8-9 and July 18.

Counts of active mites only

Delicious

Plot	Materials Sprayed July 8-9 & July 18	Mites per 100 Leaves 30/6	16/7	29/7	19/8	10/9
1	DN-111 1½ lb.	168	213	77	3273	152
2	HETP ½ pt. (100%)	58	203	17	1248	237
3	DCPM 1¼ lb. (40%)	30	219	29	1836	266
4	Am. DNOCHP 5 oz.	12	6	4	757	654
5	Mono-DNOCHP 5 oz.	2	3	8	1765	278
6	Check	6	81	250	7000	95
7	DCPM 2½ lb.	12	60	9	1339	504
8	Am. DNOCHP 2½ oz.	42	605	28	3558	160

It will be seen from the check (plot 6) that the mite population increased very slowly until the end of July. On August 25 the foliage colour was satisfactory in plots 2, 4, 5, 7, plot 1 less so (it had the highest initial population), plots 3 and 8 not quite as good as 1, and plot 6, check, showed serious injury which was clearly visible at a considerable distance.

Predators which in the absence of DDT would normally have been present in large numbers in August, were virtually eliminated in all plots. While examining leaves making mite counts the only predators found were a few chrysopid eggs, 1 chrysopid and 2 dipterous larvae on Aug. 19, and 16 Seiulus mites, 6 Stethorus larvae and 1 dipterous larva on September 10.

Acaricide Investigations - Greenhouse and Insectary Experiments

For the past two years greenhouse and insectary experiments have been conducted in order to find promising acaricides which could be used in combination with DDT and other commonly used spray materials for the control in orchards of two-spotted mite, Tetranychus bimaculatus Harvey, and European red mite, Paratetranychus pilosus C. & F. Spray manufacturing companies cooperated by supplying chemicals with acaricidal properties for testing.

The spray mixtures were prepared immediately before they were applied. Usually the ingredients were weighed out in quantities sufficient for one litre of spray, and the sequence of mixing was first to add the spreading agent, followed by the fungicide, then the insecticide, and finally the acaricide. Thorough and continuous agitation was maintained during the spraying operation.

The sprays were applied with a motor driven paint sprayer with a DeVilbiss gun producing a fine even spray under a pressure of about 20 lb. Complete and thorough coverage to the run-off stage was secured for all applications. Orvus (32% sodium lauryl sulphate) 0.25 to 0.5 lb. per 100 Imp. gal. was added to provide satisfactory spreading.

Summary of Results: The nomenclature of the new materials is in most cases that given by the manufacturers, who may follow different systems in naming organic chemicals. For this reason the names may not always correspond with those given in other papers.

Among the acaricides tested the following were found to be outstanding in their action against the two-spotted mite and the European red mite.

Di-para-chlorophenylmethylcarbinol (DMC)

This chemical supplied by the Sherwin-Williams Company (Green Cross Insecticides) was shown to possess excellent acaricidal properties. Used as a spray powder at the rate of 0.25 lb. (actual DMC) per 100 gal. it destroyed all active forms of the two-spotted mite and 99 per cent of the eggs. Against the European red mite the mortality two weeks after the spray applications was consistently 96 to 100 per cent.

A sample of a mixture of o-p. and p-p. DMC provided by the Dominion Rubber Company and processed in the laboratory to make a 25 per cent emulsion proved to be much less toxic to both species of mites, when used at the same strength as the p-p. DMC.

DMC caused no foliage injury to the test plants - bean, tomato, apple and plum. Furthermore it appeared to be compatible with all the commonly used spray materials, although the presence of hydrated lime and Bordeaux mixture delayed the effect of the DMC.

It is of interest to note that DMC has shown little or no toxicity against aphids, mealy bugs and several other greenhouse insects indicating that it is specific in its action against mites.

Di-(4-chlorophenoxy)methane (DCPM)

Supplied by the Dow Chemical Company this chemical was prepared for acaricidal use in the form of a micronized spray powder containing 40 per cent of the active ingredient. When used at the rate of 1 lb. (actual chemical) per 100 gal. not only were the active forms of the two-spotted mite destroyed but most of the eggs as well. The residual action was effective against all active stages for approximately 7-10 days in the greenhouse. When adults were placed on sprayed plants they laid large numbers of eggs before they were killed, but the unusual residual toxicity of the material destroyed nearly 100 per cent of the eggs laid during the first week. Against the European red mite DCPM was very effective destroying close to 100 per cent of the population on infested plants examined two weeks after spraying.

No foliage injury to bean, apple and plum was observed. The material gave equally good results when combined with such commonly used insecticides and fungicides as wettable sulphur, COCS, Coposil, Fermate, Bordeaux mixture, hydrated lime, lead arsenate, benzene hexachloride, and DDT.

O,o-diethyl o-p-nitrophenyl thiophosphate (3422)

This chemical supplied by the American Cyanamid Company gave excellent results when used at the rates of 2.4, 4.8 and 7.2 oz. per 100 gal. (1, 2 and 3 lb. of a 15% spray powder), destroying 98 to 100 per cent of all active forms of both the two-spotted mite and the European red mite. Against the two-spotted mite the residual action of a spray containing 7.2 oz. of 3422 per 100 gal. was over 99 per cent effective for a period of three days, and 60 per cent effective after one week. At the 4.8 oz. rate 98.2 per cent of sprayed eggs failed to hatch, and 99.2 per cent were destroyed when sprayed with 7.2 oz.

Tests also showed this chemical to be compatible with the commonly used spray materials with the exception of Bordeaux mixture. Although the immediate kill of active forms was the same whether Bordeaux was included or not, it was shown that the ovicidal and residual actions of 3422 were greatly reduced in the presence of this fungicide.

No spray injury to foliage of bean, plum and apple was observed at the 2.4 and 4.8 oz. rates, but slight injury to bean leaves occurred when sprayed with 7.2 oz. per 100 gal.

Tetraethyl pyrophosphate

At the recommended strength of 1-3200 this acaricide destroyed from 99 to 100 per cent of active mites, but there was little ovicidal or residual action. It was demonstrated that at a strength of 1-800 the residual action was 100 per cent effective against the two-spotted mite killing the new mites shortly after they hatched from the eggs.

Hexaethyltetraphosphate (HETP)

Several companies have marketed HETP under various trade names during the past season. At dilutions of 1-800 and 1-1600 a very high percentage of active mites were destroyed, but these sprays had little if any effect on eggs, and there was no residual action. It was demonstrated that two-spotted mite infestations on beans were eradicated by two thorough applications spaced 10 days apart. Essentially the same results were secured when HETP was tested against the European red mite. This acaricide was compatible with sulphur and Fermate, but in combination with lead arsenate, COCS and Coposil its toxicity was reduced, and with Bordeaux and hydrated lime was very low.

Ammonium salt of DNOCHP
Monoethanolamine salt of DNOCHP
Triethanolamine salt of DNOCHP

The three salts of DNOCHP used at 5 oz. and 2.5 oz. per 100 gal. (actual DNOCHP) initially destroyed from 94.8 to 100 per cent of the active forms of the European red mite, and infested plants examined 14 days after spraying continued to show a practically complete clean-up. The stronger dosage gave the greater kills. These acaricides are not compatible with hydrated lime, Bordeaux mixture, COCS and Coposil. Lead arsenate tended to reduce their effectiveness to some extent especially in the case of the monoethanolamine salt. The lethal action was not impaired when used with Fermate, wettable sulphur, DDT and Cupro K.

When the 40 per cent DNOCHP spray powder (DN-Dry Mix No. 1) was substituted for the straight chemical in the preparation of the salts the results secured against both the two-spotted mite and the European red mite were very similar in all respects.

There was light foliage injury on some of the test plants sprayed with the 5 oz. and 2.5 oz. strengths of the DNOCHP salts.

Dinitro-o-cyclohexylphenol (DN-Dry Mix No. 1)

DNOCHP prepared in the form of a 40 per cent spray powder by the Dow Chemical Company gave excellent results against both species of mites, destroying 99-100 per cent of all active forms at time of spraying. In greenhouse tests the residual action of a spray containing 12.5 oz. of the 40 per cent spray powder (5 oz. DNOCHP) continued to be effective for approximately 10 days, killing from 80 to 100 per cent of the two-spotted mites introduced to sprayed foliage. After 14 days the mortality was 61 per cent. Used at one half the above strength the residual action was greatly reduced. In experiments carried out during the winter of 1945-6 technically pure DNOCHP used at approximately the same strengths as the 1947 tests indicated that the material was a good acaricide but the spray injury to the test plants was extremely severe. The DN-Dry Mix spray powder caused only slight injury to bean and apple foliage and it is possible that the carrier used in the 40 per cent formulation had a safening action.

Triethanolamine salt of 2,4-dinitro-6-secondary butylphenol (DN-289)

DN-289 used at a strength of 1-1000 gave good kills of European red mite, destroying 98.5 per cent of the active forms on apple foliage examined two weeks after the spray application. At strengths of 1-2000 and 1-4000 the kills were reduced, and the residual action as determined from 14-day counts was not as effective as the 1-1000 strength. There is danger of foliage injury with this material.

1,1-di-(x-chlorophenyl)ethane (C714)

Against the two-spotted mite this chemical supplied by the Dow Chemical Company gave kills of 97 to 100 per cent at formulation (C714) strengths of 1-200, 1-400 and 1-800. There was considerable residual action at all strengths, and an ovicidal action especially pronounced at the two stronger dilutions. Foliage injury to bean resulted when sprayed with dilutions of 1-200 and 1-400.

AUSTRALIA

A. J. Nicholson, Division of Economic Entomology, Council for Scientific and Industrial Research, Canberra (Chairman, Federal Codling Moth Committee.).

Excerpt from Report of Third Annual Codling Moth Conference, May 22 and 23, 1947

In opening the discussion which followed the presentation of these reports, the Chairman concluded from the results of the last two seasons that:

(I) DDT is a good substitute for lead arsenate in codling moth control;

(II) Hexachlorcyclohexane (gamma isomer) is not a satisfactory substitute for lead arsenate;

(III) A concentration of 0.1 percent is very nearly the optimum for control of codling moth by DDT. However, nearly as good results are obtained with 0.05 percent., and for general purposes this concentration is adequate. For the reduction of heavy codling moth populations and in localities where the codling moth problem is difficult to handle, 0.1 percent should be used.

The following subjects arising out of last season's results were then discussed:

(1) The Use of Lures

The Queensland representative described a method for timing the applications of spray materials utilizing the records for lure catches from five stations as used in the Stanthorpe area, the recommendations based on the results being broadcast and circulated through the local press. A lure containing oil of sassafras was found to give a 50 percent higher catch than the old grape wine lure. Complete reliance is not placed on lure catches, growers being advised to spray at intervals of not more than three weeks even if no peaks occur in the catches after December.

In New South Wales, traps are used, but it is the general experience that moths do not enter traps readily after the New Year. Since the first spray is timed by the calyx, the use of lure traps for timing is not widely used and spraying to a set programme is usual. However, timing by means of lures is practiced in the Murrumbidgee Irrigation Area.

It was reported from South Australia that molasses had proved a better lure in Angaston, and wine more effective in Blackwood. But there is no consistency in these differences. In either centre, reliance upon one type of lure resulted in the complete loss of record of one or more major flights.

It was pointed out, however, that lures have been used in Victoria as a guide to spraying for many years, and their use had reduced the number of cover sprays by two or three.

The Chairman questioned whether the peaks accurately reflect changes in the population, or of egg laying. The general opinion was that one should not increase the period between cover sprays above three weeks, and that too much dependence should not be placed on lures.

(2) Droplet Size

The problem of droplet size was raised as a result of recent work in the United States, and the attention of States was directed to the desirability of studying droplet size in relation to complete coverage and to insecticidal efficiency.

(3) The Problem of Mites

As regards the effect of DDT on mites, the Chairman invited reports from each State. It was generally agreed that work was necessary to determine the species of mites responsible for damage to fruit trees, their source and alternative host plants, and details of their biology, especially their parasites and predators. Coccinellids of the genus Scymnus was generally reported to be plentiful, but further work was necessary on the taxonomy of this group as well as of the mites themselves.

The Chairman requested Mr. Colless, who has recently been appointed to C.S.I.R. for the purpose of studying those problems arising from the increase in mite infestations, to outline his findings, and requested that specimens of mites and their natural enemies from apples and other crops, and other plants from orchards, be forwarded to C.S.I.R. Mr. Colless referred to the world-wide experience of mite infestations following DDT treatment and to the lack of detailed information concerning their parasites and predators. He pointed out the difficulties introduced into the problem by the existence of biological races of Tetranychus.

Representatives from the States expressed gratification that C.S.I.R. was planning to undertake fundamental work on the biology of the mites.

(4) Acaricidal Sprays

Results of work on supplementary sprays to deal with the mite problem indicated that "HETP" (Hexaethyl tetraphosphate), white oil, and colloidal or wettable sulfur had been used with some success.

In New South Wales, white oil, colloidal and wettable sulfur had proved satisfactory, but in South Australia some of the sprays tested could not be used. In Queensland, it was reported that white oil had reduced the size of apples, but New South Wales experience did not confirm this conclusion. "HETP" appeared to be generally effective against adult mites, but so far only limited quantities had been available. This situation should be soon remedied. Victoria reported injuries from a combination of DDT and white oil; and while "Pespruf" (a commercial DDT preparation) and wettable sulfur had caused some fruit burn in Victoria, no ill effects were reported from its use. At Angaston, South Australia, a single white oil spray, put on with DDT at the first sign of a mite build-up (early in November) had given good control. Victoria was advising growers to use a winter spray of red oil, and to discontinue the use of DDT in the second cover spray if mites were observed.

The Chairman summed up this subject by concluding that measures should be applied against Tetranychus while the population is still small. Bryobia could be controlled more easily by winter and summer sprays. It may be possible to apply DDT plus an acaricide, e. g. "HETP" in some of the cover sprays.

(5) The Effect of DDT Sprays on Other Insects

Reported injury to bees in some small orchards in Queensland was thought to be due to DDT, but it was doubtful whether DDT was more likely to be responsible than any other calyx spray.

Woolly aphid had shown no signs of population increase in South Australia or Victoria, but in New South Wales it had increased about the middle of the season, later declining to normal. In Queensland woolly aphid appeared to be a serious problem in 1945-46, but in 1946-47 there was only a small build-up in population.

San Jose scale did not appear to have increased following DDT treatments, nor were other insect pests more prominent than usual.

The representative from Tasmania expressed the hope that C.S.I.R. would investigate certain problems that the States were unable to deal with. He referred specifically to:

(1) Particle size in relation to the effectiveness of DDT.

(2) The temperature relations of the insect.

(3) The possibility of biological control along the lines of the recent work with Dibrachys carried out under the direction of Professor H. Smith in California.

AUSTRALIA (Continued)

N. C. Lloyd, Bathurst and Orange Districts, New South Wales.

The Primary Object of Codling Moth Experiments Carried Out During the 1946-47 Season was to Compare DDT, Zinc Fluoarsenate and "666" with Lead Arsenate

Summary of Results

DDT[1/] 0.1 percent, gave excellent control of codling moth when compared with the standard lead arsenate-white oil. The inclusion of DDT 0.025 percent in the lead arsenate spray resulted in a substantial improvement.

DDT did not reduce fruit size.

DDT plus colloidal sulfur did not cause any foliage or fruit injury at Orange. However, DDT mayonnaise emulsion plus wettable sulfur did cause fruit and foliage burn at Bathurst. Spray burn was general in the Bathurst district during the past season due to the hot weather experienced.

Lead arsenate was rather ineffective in controlling calyx moth at Bathurst whereas DDT proved very effective.

Woolly aphids (Eriosoma lanigerum) did not develop on the trees at Bathurst but were plentiful at Orange. DDT checked the parasite, Aphelinus mali, but the aphid population showed no undue increase as compared with that of the lead arsenate sprayed trees.

1/ Two DDT products were tested: (1) "Pespruf" emulsion and (2) a DDT-solvent naphtha "Wetsit" emulsion.

Both red mite (Bryobia praetiosa) and red spider (Tetranychus urticae) increased on DDT sprayed trees and the latter caused a severe bronzing of the leaves at Orange. Mites were controlled at Orange by an application of colloidal sulfur 2 pounds per 100 gallons and at Bathurst by wettable sulfur 4 pounds per 100 gallons.

Apple leaf jassid (Typhlocyba froggatti) was controlled by DDT at both 0.1 percent and 0.025 percent sprays.

Zinc fluoarsenate compared very unfavorably with lead arsenate.

Benzene hexachloride ("Gammexane") again proved worthless for codling moth control.

AUSTRALIA (Continued)

E. J. Wason, Murrumbidgee Irrigation Area, New South Wales.

The Object of the 1946-47 Codling Moth Experiments was to Ascertain the Efficiency of DDT in Various Forms and Its Effect on Mites and Wolly Aphid

Discussion

DDT water-dispersible powder at a concentration of 0.1 percent gave much better control of codling moth than any of the other spray treatments.

The lead arsenate-DDT combination treatment gave satisfactory results, while the standard lead arsenate-white oil programme gave only fair control of codling moth. Zinc fluoarsenate gave very poor control, the infestation being comparable with that of the unsprayed check trees.

From two seasons' work it can now be said that the use of DDT on pome fruit for the control of codling moth in the M.I.A. stimulates the development, either directly or indirectly, of red spider and, to a lesser extent, red mite. Any spray programme employing DDT for the control of codling moth will have to include several miticidal sprays which will have to be applied at the correct time in order to prevent damage. The first of these sprays should be applied late in December. Future experimental work will be based on these lines. Needless to say, the use of such sprays will increase spraying costs.

It appears that DDT is highly toxic to the parasite, Aphelinus mali. Possibly the woolly aphid population is prevented from building up to any noticeable extent by the fact that the DDT deposit on the wood prevents young aphids forming new colonies. However, from observations made, it can be said that DDT is not an efficient spray for the control of this aphid.

AUSTRALIA (Continued)

N. E. H. Caldwell, Stanthorpe, Queensland.

The purpose of the 1946-47 codling moth experiments was to compare the effectiveness of DDT, DDT and oil combinations, and zinc fluoarsenate, with lead arsenate combinations, primarily for codling moth control, and, in addition, to obtain information on certain other pest species.

Summary of Main Results and Conclusions

1. 0.1 percent DDT gave outstanding codling moth control but the residue a month or more after the last spray application needs to be carefully considered.

2. 0.05 percent DDT was inferior to the full strength, though still superior to the arsenicals, but the residues were satisfactorily low.

3. The various DDT-oil schedules gave control of the same order as 0.05 percent DDT, but the oil appeared to increase DDT residue persistency and these residues were at or above tolerance level in all cases.

4. All DDT schedules gave excellent quality fruit the only ill effect occurring when oil replaced DDT after the end of December; here fruit weight was significantly reduced, an effect which is attributed to the oil.

5. Foliage burn was almost absent with DDT alone, and less than with oil alone in the DDT-oil schedules.

6. Woolly aphis did not get out of hand though there was some build-up in population.

7. Mite damage increased sharply on the trees receiving DDT alone but tended to be reduced in most cases where oil was involved in the schedules.

8. Lead arsenate (standard formula) gave poor moth control and caused the usual severe foliage burn.

9. The addition of lime to lead arsenate did nothing to improve it in any way.

10. The addition of zinc sulfate to lead arsenate definitely improved moth control. When added alone it caused severe foliage burn, some fruit blemishing and a reduction in fruit size. When added with lime, burn was almost eliminated, fruit size and quality were enhanced and tree health appeared to be improved. This was the only arsenical mixture not significantly inferior in moth control in all the DDT schedules.

11. Zinc fluoarsenate gave poor control of moth, caused severe foliage injury and altogether failed to live up to its overseas reputation.

12. Oil alone gave poor moth control and a substantial reduction in fruit size.

AUSTRALIA (Continued)

H. K. Kemp, Department of Agriculture, Horticultural Branch, South Australia.

Summary

Twelve trials carried out in 1945-46 and 1946-47 are reported. Summary of the result of this work follows:

1. DDT has consistently given control of codling moth superior to lead arsenate.

2. DDT evaluation curves were similar in form and behaviour to those determined for lead arsenate in past seasons.

3. Under heavy infestation in small plots 0.1 percent DDT appears to be optimum. With smaller population and/or with large areas similarly treated, 0.05 percent appears to give satisfactory codling moth control.

4. In two orchards where codling moth was uncontrolled with lead arsenate, excellent control of codling moth was obtained in one season using 0.05 percent DDT on commercial scale.

5. There is no indication that DDT spray deposit films persist any longer than lead arsenate deposits.

6. There was no significant difference in codling moth control in DDT derived from three commercial preparations of widely differing form.

7. In warm districts, build-up of Bryobia mite was invariably consequent upon the use of DDT. This was not serious in cold districts. On irrigated Williams pears mite damage effects outweighed the codling moth damage saved by DDT.

8. Pilot trial indications are that H.M.T.E.P. (hexa-methyl-tetra-ethyl-phosphate) is superior to nicotine sulfate as an acaricide.

9. White oil in pilot trial gave fairly satisfactory kill of Bryobia. Treatment of apples and pears with white oil on a commercial scale in two centres gave satisfactory results when applied early at the first appearance of Bryobia increase.

10. There was no indication of woolly aphid increase, and aphid colonies were normally parasitized by Aphelinus mali upon DDT-sprayed trees.

11. Gammexane failed in codling moth control at the concentrations tested.

12. Zinc fluo arsenate gave results inferior to lead arsenate without noticeable effect on zinc cured little leaf. Arsenical injury was somewhat less than with lead arsenate.

AUSTRALIA (Continued)

L. W. Miller, Tasmania.

Codling moth is normally not a serious pest in this area but, because of an extremely poor crop, the problem of its control was much more serious than usual. Field spraying tests were conducted using eleven spray schedules in a randomized block. A calyx and two cover sprays were applied in most schedules.

Summary of Results

Gammexane was found to be of little use against the codling moth thus confirming the result obtained from the previous season's work.

DDT used either as an emulsion, a "colloidal" suspension (Rucide), or as a dispersible powder, gave satisfactory results at a concentration of 0.1 percent DDT. There was some evidence that under Tasmanian conditions a more dilute DDT spray would prove effective.

Under the conditions prevailing in the 1946-47 season, schedules where DDT was used throughout the season were more effective than those where the DDT was replaced by lead arsenate in certain sprays.

While no very serious increase occurred in the populations of B. praetiosa or P. pilosus on trees sprayed with DDT there were indications of a build-up in the mite populations when compared to those on trees sprayed with lead arsenate. This increase was more marked for P. pilosus than for B. praetiosa.

No evidence was obtained on the effect of DDT on the woolly aphid.

AUSTRALIA

T. W. Hogan, Victoria.

Information was sought as follows:

1. Optimum concentration of DDT.
2. Effect of differences of timing of spray schedules.
3. Number of sprays necessary for effective control.
4. Effect of use of white oil emulsion with DDT.
5. Check effectiveness of a commercial suspension of DDT.
6. Overall effect of DDT by use of DDT buffers on half of the blocks.

The DDT used for all but one treatment consisted of a mayonnaise emulsion of DDT in an aromatic solvent. The suspension in the other treatment was a commercial product which is a solid combination of DDT and emulsifier, without solvent. The material is melted before use and on pouring into water forms a fine suspension of DDT. In the emulsion pure DDT (98 percent para para isomer) is used to give 20 percent actual para para isomer, whilst in the suspension a technical grade (approximately 75 percent para para isomer) to give 50 percent actual para para isomer. Marking of the fruit was consistent throughout the treatment receiving the latter material, damage consisting of black rings on the under side of the fruit. Whilst this marking does not affect the pears for canning it may cause complications in grading for export. The damage occurring in this treatment may be associated with the use of technical grade DDT.

The combination of DDT and white oil gave rise to the formation of bright yellow spots (up to 1/4 inch in diameter) on the foliage. Where white oil was alternated with DDT the trees were more evenly chlorotic but were not as seriously affected as with the combination spray.

Statistical examination of the detailed results gave the following information:

1. There is no significance between 0.1 percent DDT and 0.05 percent DDT, but both are significantly better than 0.025 percent DDT.
2. There was no significant difference in the particular timings used in this trial (wide variety of schedules using calyx and 2 to 4 cover sprays).

3. There was no significance between 3 and 4 spray applications.

4. The suspension of DDT was as good as the emulsion used for all other treatments in this trial.

5. There was no significant difference in the two buffer treatments (1) 0.1 percent DDT emulsion and (2) 5 pounds lead arsenate + 4 pints white oil to 80 gallons water.

AUSTRALIA (Continued)

C. F. H. Jenkins, Western Australia.

Codling moth has never become firmly established in Western Australia, although since 1903, fourteen separate outbreaks have been recorded.

The first five occurrences were on city and town properties, the remaining eight appeared in orchard districts.

In non-commercial areas the total destruction of fruit and trees liable to infestation was resorted to, but in fruit growing districts the quarantining of orchards and the use of arsenate of lead sprays proved effective.

Dow Chemical Company

O. H. Hammer, Midland, Michigan.

Seasonal Conditions. The southwestern Michigan fruit growing area was attended by climatic extremes in 1947. The early part of the season was characterized by frequent heavy rainfall. Low temperatures during and soon after bloom resulted in marked reduction in fruit set and severe russeting and malformation of fruits which did develop to maturity. The fruit russet was doubtless accentuated by frequent spray applications during the wet period. Mid and late summer was characterized by a severe drought and high temperatures accompanied by extensive sun-sulfur or sun-spray scald. Codling moth injury in this area was generally worse in 1947 than in 1946, doubtless due in part to grower reluctance to spray adequately to protect a small crop under high temperature conditions. Red mite was late in developing to destructive numbers and its attack appears to have been shortened by the hot dry period of August, after which it did very little damage contrary to normal experience. The two-spotted mite, on the other hand, was very destructive in certain areas, having severely bronzed the foliage and caused a heavy leaf drop by Mid-August in some instances.

Codling Moth and Mite Tests

Tests in 1947 were concerned largely with an attempt to correlate codling moth and mite control measures. Some typical results of one such test are tabulated here.

Item	Material Amounts - Applications	Codling Moth % Clean	Mites Per Leaf				
			European Red				2-Spot
			8/6	8/19	9/4	9/11	9/11
1	L.A. (3 lb.) P.F. & 5 covers	86.7	0.2	0.4	4.7	6.6	26.5
2	L.A. (3 lb.) P.F. & 1st. cov. DDT (3/4 lb.) 4 covers	95.4	5.8	12.9	1.4	0.9	62.7
3	L.A. (3 lb.) P.F. & 5 covers DN-111 (20 oz.) 2,3,5	94.9	.06	.02	0.3	0.6	1.8
4	As in item 2 plus DN-111 (20 oz.) 2,3,5	96.8	.04	0.4	0.2	0.6	1.4
5	As in item 2 plus C-726 (2 1/2 lb.) 2,3,5	97.8	.04	.04	0.2	1.2	1.5

This test was on the variety Rhode Island Greening. Treatment dates were as follows: P.F. (petal fall) June 6; covers June 18 and 30, July 14 and 24, and August 4. Of particular interest in this test is the low infestation of red mite compared with two-spotted mite on items 1 and 2, for the September 11 count. The acaricides DN-111 and C-726 (40 percent bis (p-chlorophenoxy) methane) prevented build-up of both mite species and did not detract from codling moth control. Slight foliage scorch and light fruit scald resulted from the use of DN-111 followed by high temperatures. No foliage injury, but some fruit russet followed the use of C-726.

In another series of tests on Delicious, acaricides were used in two spray schedules (1) preventative-applied before mites increased to injurious numbers, and (2) corrective-applied after mites had become sufficiently abundant to cause some foliage bronzing. Results are tabulated on page 83.

Item	Material Amounts - Applications	Mite Sprays	Red Mites Per Leaf 6/2	6/10	6/26	7/10	7/24	7/31	8/14
1	L.A. (3 lb.) pink, P.F., 1st cov. DDT (3/4 lb.) 2 covers	None	0.9	0.1	2.4	12.0	30.3	175.0	38.2
2	As item 1 plus C-726 (20 oz.) all sprays listed	Prevent	0.2	0.0	.02	.02	0.5	13.8	5.3
3	As item 1 plus C-726 (20 oz.) 2nd & 3rd cov.	Correct	--	--	16.9	7.8	1.4	2.6	1.4
4	As item 1 plus C-726 (40 oz.) 2nd & 3rd cov.	Correct	--	--	21.4	3.5	0.2	0.3	0.2
5	As item 1 plus DN-111 (20 oz.) 2nd & 3rd cov.	Correct	--	--	10.0	10.7	0.6	5.5	5.5

Spray dates were: Pink--May 20, Petal fall--June 4, Covers--June 17, 30 and July 15. Mite control was very satisfactory with both preventative and corrective treatments. Due to unfavorable weather for early development of mites the preventative treatment did not have an opportunity to show up as well as it might in a more normal year. All foliage treated with C-726 was in excellent condition at harvest. There was no russet from corrective treatments, but possibly a trace from the preventative treatment. The irregular distribution of frost injury precluded a definite decision.

In a Spy orchard with a mixed population of red mite and two-spotted mite the following results were obtained with acaricides. The codling moth sprays of DDT were applied by the grower. Treatments were essentially preventative for red mite and corrective for two-spotted mite.

Chart of mite counts follows.

Materials and Amounts/100 Gal.	Number of Sprays	Red Mites per Leaf 7/18	7/28	8/9	8/22	9/8	Two-Spotted Mites per Leaf 7/18	7/28	8/9	8/22	9/8
DN-111, 20 oz.	one	1.3	0.1	.02	0.2	5.1	10.9	0.1	0.0	0.1	10.7
	two	1.0	.04	.02	0.2	7.3	23.1	0.3	0.0	.04	8.2
C-726, 20 oz.	one	1.4	0.1	0.1	0.4	3.8	20.8	1.6	2.1	18.8	47.6
	two	1.2	0.2	0.1	0.4	3.5	21.2	2.3	1.8	13.3	46.1
C-726, 40 oz.	one	0.5	0.1	0.7	2.5	2.6	16.2	1.2	3.7	20.2	39.8
	two	0.5	0.1	0.2	0.1	1.6	27.5	0.4	0.1	0.9	11.4
HETP, 8 fl. oz.	one	0.1	0.1	0.3	1.9	3.5	24.2	7.1	0.7	22.6	75.0
	two	1.3	1.4	0.04	1.9	7.7	23.5	2.3	0.2	4.0	34.3
No acaricide	None	1.0	1.3	7.2	37.3	11.8	18.3	10.9	7.4	80.9	193.7

All plots were sprayed first on July 18. Where two sprays were used the second was applied July 29. There was no chemical injury to fruit and foliage from the use of C-726 and H.E.T.P. in these tests. DN-111 caused slight leaf scorch when followed within 72 hours by temperatures above 90° F.

Red Banded Leaf Roller

This insect was definitely more injurious in 1947 than it has been during the past six years. In a limited test, a single application made in late August when second brood larvae were feeding principly on the foliage no treatment was very effective. Lead arsenate at 3 pounds gave 46 percent control, while 1 pound of DDT gave 30 percent control. All other materials including chlordane - 1 pound, Toxaphene - 1 pound, Black Leaf 155 - 3 pounds, Black Leaf 155 - 2 pounds plus summer oil - 2 quarts, parathion - 1 pound (15 percent pwd.), and H.E.T.P. - 1/2 pint, each in 100 gallons, gave no practical reduction in fruit injury. The unsprayed trees had 29.2 percent injured fruits. The variety was Jonathan. Fruit losses on some varieties in a few commercial plantings were as high as 40 to 50 percent. Most orchards in the area showed some injury, but the average was probably less than 3 percent.

Grasshoppers.

While no effort was made to determine the species involved, grasshoppers were very injurious in several Van Buren and Berrien County orchards. In field tests, chlordane at 1 pound per acre, applied as a spray and a dust gave excellent immediate kill of nymphs and prevented reinfestation of small areas for 4 to 6 weeks during a dry period. The material was applied to the cover and lower 1/4 of the trees. Benzene hexachloride (12 percent gamma isomer) used at 1 pound per acre was not as effective as the chlordane for immediate and residual kill.

E. I. DuPont de Nemours & Company, Inc.

M. A. Vogel, Yakima, Washington.

Codling Moth and Related Problems, 1947

The first moth of the spring brood to emerge from caged larvae was taken on April 11 in West Yakima. Two emergence cages showed that more than ninety percent of the emergence occurred between April 24 and May 9 with the main peak coming on May 4. Heavy oviposition was noted several days following May 4 and there was hatching between May 10 and 17. The first moth of the second brood reared from infested thinned fruit emerged on June 24.

Growers generally did not apply a petal-fall or calyx spray but timed their first application for an early first cover. This application was started between May 5 and 9 depending upon elevation. Extremely windy weather prevailed during the spray period and some growers took up to three weeks in making their first application.

It has been estimated that more than 95 percent of the acreage in apple orchards received one or more applications of DDT during the season. Schedules for the most part only included two or three applications for codling moth control. Codling moth injury on harvested fruit was practically negligible.

Only one series of codling moth control tests was conducted during the season. This was in a block of Winesaps which carried a heavy infestation the previous season and the crop had been abandoned because of lack of codling moth control with airplane applications. A shift in a number of schedules for mite control during mid-season prevents direct comparison for codling moth control thus are not included in the attached table. Spray applications were made on the following dates: May 14, June 17, and July 21.

Overwintering eggs of the European red mite were hatching in some orchards by April 10. A heavy deposition the previous fall and favorable weather during the hatching period assured trouble from this species. Only a small percentage of growers applied a strictly dormant spray. Pre-blossom applications of liquid lime-sulfur for the control of powdery mildew were partially effective in reducing the population. The infestation, however, built up through May and June so that in many orchards supplementary control measures were necessary.

Pacific mites were moving from hibernation by the end of March and where the pre-blossom application of sulfur was made this species was effectively reduced. DN-111 was quite generally used with DDT in the first cover spray and this material gave good commercial control of this species. The dosage at which the DN-111 can safely be used in this area is not very effective against European red mites. Thus the situation arose where growers had used the DDT-DN-111 combination, the European red mites built up to damaging populations by the time summer oil could be safely applied. Since the summer oil is not effective against the Pacific mites this species built up by the time DN-111 could again be safely used. During late July and August the Pacific mite was the greatest concern.

IN-4200 in a preventive schedule gave effective control of both European red and Pacific mites at a dosage of 1-1600 in three summer applications at monthly intervals. In curative sprays during July and August it was necessary to use a dosage of 1-800 at intervals of three to four weeks to get an effective clean-up of Pacific mites. No injury was other
noted/than a yellowing of some of the older leaves following harvest.

Summary of Codling Moth Control - Holtzinger Orchard - 1947

Treatment and Dosage per 100 Gallons	1/	2/	3/	4/	5/	
1. DDT 12 oz. in 50% wettable formulation	7.2	2.8	6.8	9.3	.031	.076
2. DDT 12 oz. in 25% wettable formulation	3.6	1.0	2.1	2.9	.032	.059
11. Same as No. 1 with spreader added	0.5	1.6	7.6	8.8	.029	.039
5. DDT 6 oz. + Benzene 6/ hexachloride 6 oz.	31.0	3.5	11.9	14.8		
10. DDT 12 oz. + IN-4200 1/2 pt.	0	0.5	5.1	5.6	.062	.084
6. Methoxychlor 16 oz. in 50% form	12.0	1.5	7.3	8.6		
7. Methoxychlor 24 oz. in 50% formulation	5.0	3.9	5.9	9.5		
8. Methoxychlor 16 oz. + summer oil 2 qt.	9.0	1.5	2.7	4.0		

1/ Percent of thinned fruit with worms or stings. Checked beginning June 2.

2/ Percent of harvested fruit with worms.

3/ Percent of harvested fruit with stings.

4/ Percent of harvested fruit with worms or stings.

5/ Residue (gms/lb) 30 days after second application and 45 days after third application (harvest).

6/ DDT was used in the second and third application at the same dosage as No. 1. Benzene hexachloride was left out of the third application.

Standard Oil Company (Indiana)

C. R. Cleveland, Chicago, Illinois.

Red Spider Control Tests - 1947

Preventive Spraying

Extensive field tests were run in southwestern Michigan in 1947 primarily to test and evaluate certain spray materials and combinations in codling moth control, however, due to a heavy build-up of the two-spotted mite during the summer in certain plots, an excellent opportunity was provided to compare these materials and schedules in red spider control.

All plots received essentially the same early season sprays through the second cover, namely, a standard sulfur and lead schedule. Plots were arranged in single nine-tree squares randomized throughout a solid planting of Red Delicious. All plots were replicated on Jonathans, however, no infestation developed on this variety so that counts and observations were made only on the Delicious variety. Leaf counts were made on the center tree of each plot. Each plot was sprayed with one prescribed test material or spray combination beginning with the third cover through the sixth (final) cover spray. Spraying was done from the spray rig except in the fifth cover when each plot received an underneath spray (inside the tree) as well as being sprayed conventionally from the rig at the same time.

Control results were as follows:

1. All oil-nicotine plots, whether tank-mix nicotine bentonite oil, Nico-Sol Summer Spray Oil or summer oil - Black-Leaf Concentrate combination did not develop any infestation and, in fact, kept red spider population down to an absolute negligible amount. Foliage remained green and luxuriant throughout the summer.

2. The wettable DDT non-oil plots developed a severe infestation of red spiders. Foliage was severely injured.

3. The standard lead arsenate non-oil schedule resulted in a moderately severe spider infestation. Foliage somewhat bronzed, but much less injury than in the wettable DDT plots.

4. In the DDT-oil plots (Nonpareil Summer Spray Oil with DDT), red spiders were kept under control during the summer, but a moderate infestation developed in the fall. Foliage remained green and uninjured however as late spiders that appeared immediately went into hibernation.

Corrective Spraying Measures

A commercially sprayed Delicious block adjacent to the plot tests developed a moderately heavy red spider infestation so that it was possible to set up a series of tests designed to evaluate the degree of spider control obtained from each of six different treatments applied as special sprays.

A block of thirteen trees was selected having a moderately heavy infestation. Each of the six treatments was applied to two trees randomized throughout the block. One tree was used as a check. Two applications were made - one on August 19th and the second on August 26th. Sprays were applied from the ground with special attention being given to spraying the undersides of the leaves.

Summary of control results is as follows:

Plot No.	Treatment Amount/100 gallons	% Reduction in Red Spider Infestation*		
		24 Hours after First Spray	24 Hours after Second Spray	2 Weeks after Second Spray
1	3 qts. Superla Summer Spray Oil	75.9	98.2	86.6
2	1 pt. HETP (50%)	63.8	94.2	90.9
3	2 qt. Superla Summer Spray Oil + 1 qt. Dendrol Dormant Spray Oil	74.7	96.2	97.4
4	3 qt. Superla Summer Spray + 4 oz. Dreft	62.6	80.0	89.1
5	4 qt. Superla Summer Spray Oil	63.4	79.4	91.5
6	½ pt. HETP (100%)	74.1	94.5	94.0

*Based on average population of 73.6 spiders per leaf immediately preceding first spray application.

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E7186R

March 15, 1948

UNITED STATES DEPARTMENT OF AGRICULTURE

Agricultural Research Administration

Bureau of Entomology and Plant Quarantine

RESULTS OF CODLING MOTH INVESTIGATIONS, 1947

Part II

Work Conducted by the Bureau of Entomology and Plant Quarantine, Agricultural Research Administration, U. S. Department of Agriculture

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RESULTS OF CODLING MOTH INVESTIGATIONS, 1947

Part II

Work Conducted by the
Bureau of Entomology and Plant Quarantine,
Agricultural Research Administration,
U. S. Department of Agriculture.

This summary represents the contribution of the Division of Fruit Insect Investigations of the Bureau of Entomology and Plant Quarantine to the pool of information on the results of codling moth investigations carried on during 1947 which has been prepared in accordance with a request made by the Committee on the Codling Moth of the American Association of Economic Entomologists. Because of the general interest in insect problems arising as a result of the use of DDT for codling moth control, information has been included on the more important ones that have come to notice, including orchard mites, the red-banded leaf roller, and the woolly apple aphid. As in previous years, this is a preliminary report, circulated for the information of those interested. It is subject to revision as further review of the data may indicate, and has the status of unpublished data, not subject to quotation without permission.

The work of the Division of Fruit Insect Investigations is carried on cooperatively with several Bureau and Department units, as well as with a number of State agencies. The Division of Insecticide Investigations has continued to contribute to the work reported herein, and joint field laboratories are maintained at Yakima, Washington, and Vincennes, Indiana. The work in West Virginia is carried on jointly by the West Virginia Agricultural Experiment Station and the Bureau; the work in New York is carried on similarly with the New York Agricultural Experiment Station.

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KEARNEYSVILLE, WEST VIRGINIA

James F. Cooper and Elwood O. Hamstead, Bureau of Entomology and Plant Quarantine, United States Department of Agriculture and Edwin Gould, West Virginia Agricultural Experiment Station.

These investigations were carried on jointly by the Bureau of Entomology and Plant Quarantine and the West Virginia Agricultural Experiment Station.

1947 Seasonal Conditions

Below freezing temperatures on the mornings of May 8, 9, 10 and 11 caused high mortality of apple bloom and some peach fruits in low areas. The apple crop in this area was reduced about 40 percent below the normal average.

Cool weather in May and June facilitated codling moth control. Spring brood activity began about May 19 and was practically over by June 6. First brood activity was extremely light.

The first spring brood red-banded leaf roller adults were noted on April 11 and spring brood adult activity of this insect appeared to be over by May 11. First brood moths were taken in bait pails on June 25 and continued active throughout July. Activity noted in the pails beginning on August 19 was doubtless second brood moths. Moths were collected as late as September 19.

The cool weather of May, June and July retarded mite population development. No appreciable increase was noted until early August when populations of both Tetranychus and Paratetranychus developed rapidly. A few heavy infestations were noted in July. Populations of the two genera appeared to be about equal throughout the season.

1947 Field Spray Tests

Objectives

To determine the relative effectiveness of various materials and combinations for control of codling moth, red-banded leaf roller and orchard mites and their effect on foliage and fruit finish. Also to test application of concentrates as a mist spray. Information on disease control was also obtained but has been omitted from this report.

Methods

The plot system used, with two exceptions which will be indicated later, was a randomized distribution of single-tree plots with five replications.

All sprays, except the mist applications, were applied with standard power orchard sprayers having 35-gallon per minute pumps operated at approximately 500 pounds pressure. Two 8-nozzle broom type guns, one from a tower and the second from the ground, were used except in the Phillips orchard where one single-nozzle gun was employed.

Codling moth infestation was so light that no first brood counts were made and dropped fruit was not scored until harvest. Randomized samples of 200 apples from each tree were scored from both picked and drop fruit at harvest for insect and disease injury. Mite populations were determined from collections of 100 leaves per plot at each examination. The leaves were brushed and mites collected on glass plates and counted. Adults and nymphs of Paratetranychus and Tetranychus were counted separately but figures in the tables include total forms of both genera.

Materials used in tests:

LS - liquid lime sulfur
FS - Koppers sulfur paste
lime - hydrated spray lime
Fer - Fermate--70% ferric dimethyl dithiocarbamate
Bordo - copper sulfate-lime Bordeaux mixture
LA - lead arsenate
DDT - 50 percent wettable powder (Amounts given in tables are actual DDT)
Ryanex - 100% special spray grind of Ryania
Ryania conc. - Ryania spray concentrate SC-50
Rhoth - Rhothane D-3 - an emulsible solution of 25% dichloro diphenyl dichloroethane, 65% xylol and 10% Triton X-100
BHC - 50% wettable powder of benzene hexachloride containing 6% gamma isomer
Z-1 - a deposit builder - petroleum sulphonate and combined fatty acids
nic. - 40% nicotine sulfate
TEP - tetraethyl pyrophosphate
HETP - hexaethyl tetraphosphate
C-726 - a 40% di-(4-chlorophenoxy) methane wettable powder
DN-111 - a 20% dinitro-o-cyclohexylphenol wettable powder
3422 - a 15% parathion wettable powder
chlor. - chlordane

Block A, Show Orchard, Shepherdstown, W. Va.

Objective

To determine the relative effectiveness of various materials and combinations in the control of codling moth, red-banded leaf roller, European red mite, and red spiders and the effect of such schedules on the foliage and fruit finish in a block of Northwestern Greenings. The schedules used and results obtained are given in Tables I and II.

Table I. Spray Schedule - Block A - Show Orchard, 1947

Plot No.	Materials (Amounts per 100 Gallons) and Application Dates					
	Pink 4/28	Petal-Fall 5/12	1st Cover 5/22	2nd Cover 6/2	3rd Cover 6/13	4th Cover 6/23
1	6 qt. LS	12# FS 3# lime 3# LA	10# FS 3# lime 3# LA	8# FS 3# lime 3# LA 1# DDT	1/2-2 Bordo 3# LA 3/4# DDT	2-4 Bordo 1# DDT
2	6 qt. LS 1/2# DDT	12# FS 1# DDT	10# FS 1/2# DDT	8# FS 1/2# DDT	1/2# DDT	2-4 Bordo 1# DDT
3	12# FS 1/2# DDT	12# FS 1# DDT	10# FS 1/2# DDT	8# FS 1/2# DDT	1/2# DDT	2-4 Bordo 1# DDT
4	12# FS 2# DDT	12# FS 2# DDT	10# FS 2# DDT	8# FS 2# DDT	2# DDT	2-4 Bordo 1# DDT
5	12# FS 2# BHC	12# FS 2# BHC	10# FS 2# BHC	8# FS 2# BHC	2# BHC	2-4 Bordo 1# DDT
6	12# FS 1/2 pt HETP	12# FS 1/2 pt HETP	10# FS 1/2 pt HETP	8# FS 1/2 pt HETP	1/2 pt. HETP	2-4 Bordo 1# DDT
7	12# FS	12# FS 3# lime 3# LA	10# FS 3# lime 3# LA	2-4 Bordo 3# LA 1# DDT	2-4 Bordo 3# LA 3/4# DDT	2-4 Bordo 1# DDT
8	12# FS	12# FS 3# lime 3# LA	10# FS 3# lime 3# LA	8# FS 3# lime 3# LA 1# DDT	3/4# DDT	2-4 Bordo 1# DDT
9	12# FS	12# FS 1/2 pt HETP	10# FS 1/2 pt HETP	8# FS 1# DDT	3/4# DDT	2-4 Bordo 1# DDT
10	12# FS	12# FS 3# lime 3# LA	10# FS 3# lime 3# LA	8# FS 1# Fer 3# LA 1# DDT	1 1/2# Fer 3/4# DDT	2-4 Bordo 1# DDT

Table II. Results Block A - Show Orchard - 1947

Plot No.	Mites and Eggs per 100 Leaves							Fruit Injury (%)	
	5/29	6/3	6/25	7/16	7/24	8/4	8/21	Leaf Roller	Codling Moth
1	80	88	308	584	968	1584	1632	0.5	2.2
2	64	96	496	1036	2016	2056	1440	7.9	5.8
3	64	104	484	1164	1352	1024	1932	9.3	3.5
4	16	56	184	560	952	792	896	3.3	5.7
5	72	116	638	888	1472	1936	1456	9.1	8.3
6	16	20	8	302	592	1376	1368	13.2	4.0
7	32	0	799	1632	1952	2304	3808	0.1	4.0
8	128	116	169	2440	1400	1592	1720	1.6	4.1
9	8	76	12	224	448	528	840	13.0	4.9
10	112	80	420	840	1496	1904	1388	1.4	3.1

Summary and Conclusions

Codling Moth

All schedules and materials except benzene hexachloride (No. 5) gave excellent control of codling moth. The best control was obtained with the standard schedule (No. 1) in which lead and DDT were combined in the early codling moth sprays. The concentration of 1/2 pound DDT (Nos. 2 & 3) gave control equal to the 2 pound concentration (No. 4). A full schedule of hexaethyl tetraphosphate (No. 6) also gave good control of the codling moth.

Leaf Roller

Lead arsenate was the most effective material for the control of the leaf roller. Its use in the petal-fall and first two cover sprays (Nos. 8 & 10) gave very effective control but there appeared to be a slight increase in control when it was added again in the third cover spray (Nos. 1 & 7). A concentration of 2 pounds of DDT (No. 4) gave a very satisfactory degree of control but when the concentration was reduced to 1/2 pound (Nos. 2 & 3) the control was not satisfactory. Benzene hexachloride and hexaethyl tetraphosphate (Nos. 5, 6 & 9) failed to give satisfactory control.

Mites

The results indicate that hexaethyl tetraphosphate used in the petal-fall and first cover followed by DDT (No. 9) gave better control of mites than a full schedule of hexaethyl tetraphosphate (No. 6). A full schedule of a concentration of 2 pounds of DDT (No. 4) also gave a fairly high degree of control but when the concentration was reduced to 1/2 pound (Nos. 2 & 3) there was no evidence of any degree of control. There was no significant difference in mite populations on plots 2 and 3 receiving DDT throughout and those receiving no DDT prior to the second cover spray (Nos. 1, 7, 8 and 10). The use of a heavy Bordeaux (No. 7) appears to stimulate mite population build-up.

From the standpoint of effect on foliage and fruit finish treatments numbers 2 and 5 were least objectionable while numbers 7 and 9 were most objectionable.

Block C - Seibert Orchard, Berkeley County, W. Va.

Objective

To determine the relative effectiveness of lead arsenate, DDT wettable powders and emulsions, Ryania and DDD (Rhothane) and combinations for control of codling moth, red-banded leaf roller and mites and their effect on foliage and fruit finish in a block of Northwestern Greenings. Four cover sprays were applied (5/27-28, 6/5-6, 6/17 and 6/27-28) with one exception in which the third cover was omitted. Disease control programs used in combination with the insecticides varied considerably and involved the use of flotation sulfur and/or fermate in the first and second covers and fermate or Bordeaux mixture in the third and fourth covers.

Poor spraying in previous years and poorly timed and applied preblossom and postblossom sprays in 1947 by the owner had permitted heavy infections of scab and apple blotch prior to the beginning of our tests.

Because of the small differences between treatments the detailed spray schedules and results are not given.

Summary and Conclusions

Codling Moth

Excellent control of codling moth was obtained with all schedules. Less than one percent injured fruit was recorded on plots sprayed with Ryanex, Ryania concentrate, DDT-xylol emulsions, and lead arsenate-DDT combination schedule. Poorest control (2.9 percent injured fruit) was obtaincd on a plot given a 4-cover lead arsenate-Fermate schedule but a similar schedule on another plot was among the cleanest.

Leaf Roller

The leaf roller population was apparently too light in this orchard to produce significant differences in treatments. Less than 1.2 percent injured fruit was obtained in all schedules having lead arsenate in either the first two or the first three cover sprays while schedules with only DDT as the insecticide had from 1.7 to 3.9 percent injured fruit. Only 0.3 percent of the fruit was injured on the plot sprayed with Rhothane while injury reached 5.9 percent on the plot sprayed with Ryanex and 3.7 percent on the one sprayed with Ryania concentrate.

Mites

The only sampling for mite populations was made in this block on August 15 to determine whether abnormally heavy or light mite populations had developed on any schedules. The average population for the entire block was 10.6 mites per leaf and individual plot populations ranged from 4.5 to 24.0 mites per leaf. The population of nymphs and adults indicated that approximately half the population was Paratetranychus and half Tetranychus. Neither DDT nor lead arsenate appeared to be a factor in development of mite populations except in the case of DDT emulsion formulae on which the populations were high. Populations were below the average on the two Ryania and the Rhothane plots.

Fruit and Foliage Condition

Scab and blotch injury rendered difficult a true estimate of the effect of the spray schedules or materials on fruit and foliage. However the three plots with the best foliage condition had received Fermate in all cover sprays with no Bordeaux in any. Foliage condition on the only other plot not receiving Bordeaux was rated fair or average. Foliage condition on the four plots receiving the DDT emulsions was consistently poor. One factor which possibly influenced this was the high mite populations on these plots.

Block D - Seibert Orchard, Berkeley County, West Virginia

Objective

To determine the relative value of fermate in comparison with Bordeaux mixture in the control of apple blotch and the effect of such schedules on the control of mites, codling moth, leaf roller and scab and their effect on foliage and fruit finish. The tests were made in a block of 17-year old Northwestern Greening trees which showed localized centers of blotch canker infections. All plots received the same insecticide treatment as follows: (Amounts per 100 gallons of spray) lead arsenate, 3 pounds, 5/28 (first cover); DDT, 3/4 pound, 6/6 (second cover) and 6/27 (fourth cover); and DDT, 1/2 pound, 6/17 (third cover).

Summary and Conclusions

Mites

The only significant results on mite control were noted where the heavy Bordeaux schedule was used. Here again, as in experiment Block A (Show orchard) the use of a heavy Bordeaux definitely stimulated mite population build-up. This population increase appears to be in direct ratio to the number of applications and the amount of Bordeaux used. These data are further supported by consistent results obtained in previous experiments.

Codling Moth

All treatments gave a very high degree of control of codling moth. There was no significant difference in degree of control between treatments. This was expected since the insecticides used were standard for all schedules.

Leaf Roller

The results on leaf roller infestation indicated that there were no significant differences between treatments. These results were expected since the insecticides used were standard for all schedules and not considered to be very effective in the control of the leaf roller.

Foliage Condition

A careful rating of the foliage condition at harvest time showed clearly that the heavy Bordeaux schedules gave significantly more foliage injury than any of the fermate schedules. This is very important and may offer at least a partial explanation of the widespread injury from the use of Bordeaux in many commercial orchards throughout this area. The use of heavy Bordeaux is closely associated with heavy mite populations. The heavy mite populations cause severe damage to the foliage. The injury caused by Bordeaux is always more severe on weak foliage. This would lead to the conclusion that much of the damage attributed to Bordeaux may have been aggravated by weak foliage resulting from heavy mite populations, hot dry weather or some other natural factor.

Block B - Butler Orchard, Berkeley County, West Virginia

Objective

To determine the effectiveness of various materials and combinations for control of European red mite and red spider mites. Twenty plots had been set up in a Stayman block in the Butler orchard for tests

for control of codling moth, leaf roller and mites. Spring freezes practically eliminated the fruit in this block and the studies on codling moth and red-banded leaf roller were shifted to another orchard (Block C in Seibert orchard), but the program on mites was continued.

A petal fall and four first brood cover sprays were applied. Acaricides were added to eight schedules in the second and third covers and two supplementary applications of acaricides alone were made on August 18 and 25 when the mite populations in the block reached an average of 7.7 forms per leaf.

Summary and Conclusions

Measurement of the effectiveness of the materials added in the first brood codling moth sprays is obscured by the light mite populations existing at that time. A normal population decline occurred about the time of the August applications and somewhat obscures the effectiveness of those applications. However, a noticeable reduction in populations was effected by parathion (3422), Dow's C-726 (di(4-chlorophenoxy)methane) and DN-111, hexaethyl tetraphosphate and tetraethyl pyrophosphate. Mite populations were consistently lower in the Khothane plot and in the plot where hexaethyl tetraphosphate was added in the petal-fall and first cover sprays. Mite populations on a plot sprayed with a DDT-chlordane emulsion also remained low until late in the season.

Phillips Orchard, Shepherdstown, West Virginia

Objective

To determine the relative effectiveness of various materials in control of European red mite.

Early in July a heavy mite population, practically 100 percent Paratetranychus pilosus, was noted in the Phillips orchard near Shepherdstown, W. Va. A regular spray program had been carried through the first brood codling moth schedule by the operator. A block of 22 Delicious trees separated from the balance of the orchard was divided into 11 plots of 2 adjacent trees each for a series of tests of acaricides. Two spray applications were made at eight day intervals. A single nozzple gun operated from a 35-gallon per minute orchard sprayer was used and the trees sprayed thoroughly first from the inside and then from the outside. Mite samples were taken immediately prior to the first application, two between applications and seven following the second application to provide a study for a period of two months from the initial application of acaricides. Each sample consisted of 25 leaves taken from each tree from the ground on the side next to its replicate to avoid effect of drift.

Summary and Conclusions

Generic separation of the adult and nymphs indicated that from 99.8 to 100 percent of the population was Paratetranychus pilosus between July 10 and July 28, 94 percent on August 8, 96 percent on August 20 and 87 percent on September 10. An increase in Tetranychus sp. in late August did not affect the control figures until the last examination on September 10 when the overall population reduction averaged 59 percent as compared to 64 percent for Paratetranychus alone.

All materials gave excellent mite control as used in two applications. A reduction in population of 98 percent was attained in all plots. Plots 13 (1/2 pint HETP) and 18 and 20 (1 1/2 and 1/2 pound 3422) gave the greatest reduction from the first application. Plots 11 (oil), 14 (1/4 pint HETP), 16 (1/2 pint TEPP) and 21 (DN-111) showed earliest indications of mite recovery. The one pint dosage of hexaethyl tetraphosphate and 1/2 pound dosage of 3422 gave the best overall performance in these tests. Details of the results are shown in Table III.

Table III. Spray Schedule and Results – Phillips Orchard — 1947

Plot No.	Materials per 100 Gallons	Mites and Eggs per 100 Leaves (first line). Reduction in Mite Population from Initial Population of July 10 (second line). 7/10	7/11	7/14	7/17	7/19	7/21	7/23	7/25	7/28	8/5	8/20	9/10
11	6 qt. oil	12040	spray	7552 37	2752 77	spray	392 97	552 95	168 99	248 98	800 93	1376 89	4320 64
12	1 pt. HETP	24288	spray	8352 66	6416 74	spray	664 97	160 99	184 99	216 99	304 99	1424 94	3184 87
13	1/2 pt. HETP	12960	spray	2480 81	2152 83	spray	416 97	136 99	160 99	120 99	296 98	704 95	3328 74
14	1/4 pt. HETP	9664	spray	4096 58	2832 71	spray	352 96	224 98	240 98	232 98	696 93	2960 69	1376 86
15	1 pt. TEP	8112	spray	2328 71	2336 71	spray	448 94	272 97	120 99	88 99	128 98	576 93	3184 61
16	1/2 pt. TEP	10352	spray	3084 70	4208 59	spray	736 93	320 97	160 99	248 98	416 96	2368 77	2592 75
17	1/4 pt. TEP	12376	spray	9296 25	6720 46	spray	584 95	544 96	312 97	224 98	192 98	1648 87	2512 80
18	1-1/2# 3422	13424	spray	5360 60	1052 92	spray	472 96	464 96	408 97	280 98	200 99	400 97	2696 80
19	1# 3422	14704	spray	3760 74	3856 74	spray	648 96	336 98	256 98	128 99	160 99	480 97	2960 80
20	1/2# 3422	14128	spray	2816 80	1840 87	spray	344 98	132 99	120 99	132 99	248 98	512 96	2272 84
21	1-1/4# DN-111	10824	spray	7328 32	3024 72	spray	520 95	224 98	320 97	192 98	288 97	864 92	2592 76

Block E - Seibert Orchard, Berkeley County, West Virginia

Objective, Method, and Materials Used

The object of this experiment was to test methods of applying insecticides in a concentrated liquid [redacted] form and to develop suitable formulations. A double-outlet Bean mist duster fitted with capillary jet nozzles was used to apply the concentrate materials in the form of a fine spray or mist. The single-tree, two replication plot system was used. Due to late spring freezes it was necessary to change the location of this experiment and it was not set up in this block of 17-year old Northwestern Greenings until after the petal-fall application. As a result of poor early spraying a heavy infection of scab had already occurred when the experiment was begun. This block of trees also showed heavy localized centers of apple blotch canker infections. Poor spraying during past seasons had permitted the build-up of these heavy centers of infection but they had not yet had time to spread uniformly throughout the entire block.

Materials Used in Mist Spray Formulae

DDT - aerosol grade - Merck & Co.
Xylol - industrial grade - The Neville Co.
Benzol - industrial grade 90% benzol - The Neville Co.
Carbon tetrachloride - technical grade - B. R. Elk
Oil - Horticultural base oil AGX-54 - Shell Oil Co.
Emulphor - Emulphor DDT - General Dyestuffs Corp.
Triton X-100 - Rohm and Haas
Aluminum stearate - Technical D (di-acid stearate) - Mallinckrodt Chem.
Ryania concentrate SD-100 - A Ryania concentrate of which 4 ounces is the equivalent of 6 pounds ground wood - Merck & Co.

Spray applications were made as follows:

1st cover .....May 28-29
2nd cover .....June 9
3rd cover .....June 18
4th cover .....June 30

Schedules used are given in Table IV.

Table IV. Spray Formulae - Block E - 1947. Mist Spray Tests - Seibert Orchard

Plot No.	Materials per gallon of emulsion with water. One gallon emulsion applied per tree per application except Plots 88, 89, and 90 which received 1/2 gallon per tree
71	Check Plot - Sprayed with regular power equipment using 1/2# DDT (actual) per 100 gallons at 25 gallons per tree.
72	4 oz. DDT, 12 oz. benzol, 12 cc. emulphor
73	2 oz. DDT, 12 oz. benzol, 12 cc. emulphor
74	2 oz. DDT, 6 oz. xylol, 6 cc. emulphor (standard xylol formula)
75	4 oz. DDT, 12 oz. xylol, 12 cc. emulphor
76	2 oz. DDT, 12 oz. xylol, 12 cc. emulphor
77	2 oz. DDT, 12 oz. benzol, 12 cc. emulphor, 5 gm. aluminum stearate
78	2 oz. DDT, 12 oz. xylol, 12 cc. emulphor, 5 gm. aluminum stearate
79	2 oz. DDT, 6 oz. benzol, 5 oz. oil, 12 cc. emulphor
80	2 oz. DDT, 6 oz. xylol, 5 oz. oil, 12 cc. emulphor
81	2 oz. DDT, 6 oz. benzol, 5 oz. oil, 12 cc. emulphor, 5 gm. aluminum stear.
82	2 oz. DDT, 6 oz. xylol, 5 oz. oil, 12 cc. emulphor, 5 gm. aluminum stear.
83	2 oz. DDT, 12 oz. carbon tetrachloride, 12 cc. emulphor
84	2 oz. DDT, 6 oz. benzol, 6 cc. Triton X-100
85	2 oz. DDT, 6 oz. xylol, 6 cc. Triton X-100
86	2 oz. DDT, 6 oz. benzol, 6 cc. emulphor (except in 3rd cover when a water-in-oil formula of 2 oz. DDT, 12 oz. xylol, 56 oz. oil, 1 1/2 oz. emulphor was used)
87	2 oz. DDT, 6 oz. benzol, 6 cc. emulphor (except in 3rd cover when an oil-in-water formula of 2 oz. DDT, 12 oz. xylol, 56 oz. oil, 1 1/2 oz. emulphor was used)
88	4 oz. DDT, 12 oz. benzol, 12 cc. emulphor
89	4 oz. DDT, 8 oz. benzol, 5 oz. oil, 13 cc. emulphor
90	4 oz. DDT, 20 oz. benzol, 20 cc. emulphor
91	2 oz. DDT, 5 oz. benzol, 5 oz. xylol, 12 cc. emulphor
92	2 oz. Ryania concentrate SD-100
93	2 oz. DDT, 6 oz. benzol, 6 cc. emulphor (Standard DDT-benzol formula)

Summary and Conclusions

Mites

The results of an examination of suitable samples on August 7 showed a rather wide variation from 344 to 1856 per 100 leaves in the degree of infestation of mites between plots on that date. It is believed this was probably due to natural variation rather than to the control efficiency of the various treatments. The two replications are not adequate to afford accurate readings of a given mite population.

Codling Moth

The degree of codling moth control was so high that there was no apparent significant difference between the various treatments. The concentrated materials appeared to give as effective control, 0.9 to 5.4 percent injured fruit, as the diluted materials applied with a pressure sprayer, 2.8 injured fruit. The ease with which the codling moth was controlled, however, depreciated the importance of the results obtained.

Leaf Roller

The results on the control of the red-banded leaf roller were not significant. There was no apparent significant difference in the degree of control effected by the various treatments. The relative low degree of infestation in all plots indicated that the natural infestation in this orchard was low. This is supported by the fact that the infestation in plot 71 was low, 2.3 percent injured fruit, and other experiments indicate that this schedule will not give effective control of the leaf roller where an important population exists.

Foliage Condition

It was difficult to distinguish between spray injury and that caused by the heavy infection of scab and blotch. None of the plots showed good foliage. Throughout the season there was evidence that several of the treatments were causing foliage injury but the foliage was in such a weakened condition, due to disease infection, that almost any type of spray would cause still further injury. Careful rating of the degree of foliage injury at harvest time failed to give any clear evaluation as to the relative effect of the various treatments on the foliage and fruit finish. Evidence indicated however that certain of these treatments were injurious to the foliage but the extent of this injury could not be determined under these conditions. However, such severe foliage injury was inflicted by the 50-percent oil formulation used in plots 86 and 87 that no further attempt was made to test this formulation. Moderate foliage injury was noted in midsummer on plots 75, 76 and 78 which received formulations containing 12 ounces of xylol per gallon of emulsion.

VINCENNES, INDIANA

L. F. Steiner, In Charge 1/

Rainfall and mean daily temperatures at Vincennes for the six-month period from April through September 1947 follow:

	APRIL	MAY	JUNE	JULY	AUG.	SEPT.
Precipitation (Inches)	7.61	4.11	6.02	2.07	1.65	4.34
Deviation from normal	+3.61	+ .02	+1.72	-1.43	-1.90	+0.63
Mean daily temperatures (°F.)	55.5	62.6	72.2	73.6	83.2	70.6
Deviation from normal	+0.1	-3.5	-2.7	-5.5	+5.9	-0.5

The subnormal temperatures which prevailed until the last week in July slowed insect development. Apple harvest was almost a month later than normal. Codling moth emergence began May 11, about a week later than normal. The peak of first-brood hatch occurred between June 5 and 10. The peak of second-brood hatch began about July 26 at the start of a seven-week period of ideal codling moth weather. There was time for only a moderate third-brood attack. In most orchards the present codling moth carryover is twice that of a year ago. Conditions were unfavorable for orchard mites until late in July and damage was less than normal.

Laboratory Experiments with DDT and Acaricides

Under laboratory conditions, in the absence of predators the reproductive rate of Tetranychus bimaculatus (Harvey)(starting with hibernating females) was 50 percent less on lima bean plants dusted with 5 percent DDT and slightly, but significantly, less on plants sprayed with a 50 percent wettable powder (0.75 lb./100 gal.) than on untreated beans. The plants were treated before the application of 10 females per plant (8 or 9 plants per test) and the results were determined 10 days later. This adds further evidence to that previously reported to the effect that predator mortality from DDT sprays or residues is the principal reason for mite outbreaks where DDT has been used.

1/ The chemical analyses and particle size determinations (by the air permeation method) reported herein were made by the Division of Insecticide Investigations, J. E. Fahey, in charge. Several of the DDT formulations were also prepared by Mr. Fahey.

In numerous other tests on beans during March and April the technical grade of TEPP (tetraethyl pyrophosphate) concentrate appeared only twice as toxic to T. bimaculatus as HETP (hexaethyl tetraphosphate) in both spray and dust forms (later verified by field tests). Walnut shell flour proved to be an excellent diluent for use in such dusts. A one percent TEPP dust equalled a one percent parathion dust. TEPP and HETP dusts had more residual efficiency than sprays containing up to 4 ounces TEPP or 8 ounces HETP per 100 gallons. Outstanding results were obtained with a 15 percent parathion wettable powder at dilutions as great as 4 ounces per 100 gallons. Technical DDT at 8 ounces per 100 gallons in a xylene emulsion gave approximately the same control of mites as chlordane or Toxaphene similarly used but the latter proved most effective against adult mites.

Wettable sulfur and HETP in combination was almost twice as effective as either alone, but a fused bentonite-sulfur reduced the effectiveness of the HETP.

Ichneumonid parasites, Itoplectis conquisitor (Say) and Coccygomimus aequalis (Prov.) reared in April from red-banded leaf roller pupae proved very susceptible to deposits from 1 pound DDT per 100 gallons when exposed to sprayed surfaces more than 30 minutes. These two species were the principal parasites reared from hibernating material.

Laboratory-Field Experiments

The usual method of conducting these experiments was followed (Bureau Circular E-448, September 1939). Approximately 150,000 newly hatched larvae were applied to apples sampled for these tests.

The principal tests were divided among 3 series, two of which were set up as replicated small plot field tests, and from which the larvicidal efficiency data were obtained to supplement the field data. The third series was arranged on uniform moderate sized Rome Beauty trees, two per plot, to compare DDT formulations of different particle sizes, following up work started in 1944. Sprays were thoroughly applied from tower and ground with a conventional sprayer at 600 pounds pressure.

The results of tests to determine the influence of particle size are given in Table 1.

Table 1. Average Percent Efficiency and Deposits Obtained with DDT Formulations of Different Particle Sizes. Vincennes, Ind. 1947

Plot No.	Materials per 100 Gallons[1]	0 to 1 Day After Sprays		11 to 25 Days After Sprays	
		Effic. %	DDT mmg/cm²	Effic. %	DDT mmg/cm²
18	DDT (aerosol), 1.9 microns SMPD[2] 0.5 lb. + Triton B-1956, 0.5 oz.	99.9	5.6	81.4	2.8
19	DDT (aerosol), 2.7 microns SMPD 0.5 lb. + Triton B-1956, 0.5 oz.	99.6	5.9	88.4	2.8
20	DDT (aerosol), 5.0 microns SMPD 0.5 lb. + Triton B-1956, 0.5 oz.	99.3	6.4	84.6	2.7
22	DDT (aerosol), 5.0 microns SMPD 0.5 lb. + Bancroft clay 0.5 lb. (milled together in mikropulverizer)	98.4	7.5	84.8	3.6
23	DDT-50 wettable 1 lb. 1946 proprietary brand, SMPD 8.95 microns	96.4	5.0	65.6	1.9
24	Same as 23, reground in Mikropulverizer to SMPD of 6.5 microns	98.7	6.4	75.3	2.3

1/ Six DDT sprays were applied following a calyx and two cover sprays of lead arsenate.

2/ Surface mean particle diameter determined by air permeation measurements.

The aerosol grade of DDT was used for certain of the tests, because more uniform and smaller sized fractions could be prepared without the use of a diluent, than was possible with the technical grade.

In these tests differences of 3 percent in efficiency are highly significant. At the start of these tests the five micron material was significantly inferior to the smaller sizes but during July the 1.9 micron material was the least effective of the three sizes. Particle size determinations at the end of the season showed that the SMPD had increased to 2.5, 3.5 and 5.25 microns. The proprietary brand which with its diluent showed an SMPD of 7.6 microns early in 1946 increased to 8.95 in 1947. That which was reduced to 6.5 microns by reprocessing in May 1947 increased to 7.1 microns by September.

Since the proportionate increase in particle size through fusion of particles was greatest in the fine material and no information is available with regard to how much of the DDT was tied up in agglomerates, it is not possible from the available evidence to determine if effectiveness can be increased by decreasing particle size below three microns. It is probable that the air permeation measurement is misleading where many of the particles are fused together. It seems likely that agglomerates may be held together loosely enough to be recorded as individual particles, yet might be deposited as agglomerates having the toxicity of large single particles. The results corroborate evidence obtained in 1945 and 1946 to the effect that particles having a surface mean diameter of three microns are more effective than larger sized particles and that prolonged high temperatures do not accelerate loss of deposit or toxicity as the particle size is decreased to this size. Daily maximum temperatures during August ranged from 83 to 104° and averaged 93.7° F.

The results with the factory-processed material, widely sold in 1946 and 1947, suggest that manufacturers can still improve their formulations by reducing particle size, also that formulations held over from one year to the next may lose some of their effectiveness.

The results of tests with parathion on mature Golden Delicious trees are tabulated below:

Plot	Cover Spray	Materials per 100 Gallons	Percent Larvicidal Efficiency									
			B (Before Spray)	A (After Spray)								
			2(6/10)	3(6/20)		4 (7/3)		5 (7/16)		6 (8/6)		Harvest
			After	B	A	B	A	B	A	B	A	9/22
32	1-2	Lead ars. 2 lb. + DDT-50, 0.75 lb. + Karbam	86	61	98	69	100	96	100	89	100	86
	3-7 8 1/	DDT-50, 1.5 lb. Parathion 15%, 4 oz.										
37	1	Same as 32	100	66	-	32	100	98	100	94	100	80
	2,4-6	Parathion 15%, 4 lb.										
38	1,2	Same as 37	100	66	-	32	100	100	100	96	100	70
	4-6	Parathion 25%, 2.5 lb.										
41	1	Same as 37	100	93	-	55	100	92	100	97	100	-
	2	Parathion 15%, 2 lb. + oil, 1 qt.										
	4-6	Parathion 25%, 1.25 lb. + oil 1 qt.										
Parathion deposits in mmg/cm^2		Pl.	37	-	-	-	2.4	1.7	7.4	0.5	7.6	0.4
		Pl.	38	-	-	-	4.2	2.5	9.6	1.2	6.6	0.3

1/ Applied to part of plot 32 two days after last spray to check severe mite damage.

Because of lack of material, sprays 3 and 7 were omitted from the parathion plots 37, 38 and 41. Because of insufficient larvae no determinations could be made before and after the seventh cover was applied to the DDT plots. It is important to note that during the seven weeks between the final spray and harvest the efficiency declined only to 80 and 70 percent on plots 37 and 38, respectively.

The larvicidal efficiency at harvest four weeks after the final spray on DDT plots other than 32 ranged from 80 to 95 percent. These included deposit builders (Colloidal Products Co. Z-1) or acaricides such as HETP, TEPP, Dow-726 or nicotine bentonite plus DDT and oil. The addition of special sprays of 0.25 and 1.00 pound parathion 15 percent to parts of plot 32, two days after the last DDT spray, had significant effects on the residual efficiencies at harvest. The efficiency was 95 percent where 1 pound was added and 86 where 4 ounces were used.

There appears to be no significant difference in toxicity to codling moth of the 15 and 25 percent parathion formulations. On an equal basis of active ingredient, DDT and parathion appear equally effective in preventing worm entrances. In the prevention of stings parathion was only 1/15 to 1/2 as effective as DDT except when its deposits were excessive. For example, on July 15 the samples from 5 DDT plots were entered by 2.5 to 6.2 percent of the worms and stung by 1.3 to 3.3 percent. Those from the three parathion plots were entered by 0.2 to 5.7 percent but were stung by 21 to 36 percent.

One other acaricide, Dow-726 at 3 pounds per 100 gallons, showed a substantial initial efficiency against codling moth but it lost effectiveness more rapidly than parathion. This material contains 40 percent di (4,4(-chlorophenoxy) methane).

The results of most other laboratory-field tests were in agreement with first-brood and final infestation counts. The addition of 2 pounds DDT (50 percent) to the second and third cover sprays of a split lead arsenate-nicotine bentonite program had no detectable effect on larvicidal efficiency after the fourth cover spray. The combination of 3 pounds lead arsenate and 2 pounds micronized phenothiazine was less efficient after periods of weathering than 1.5 pounds DDT 50 and when both were followed by three second-brood sprays of 1.5 pounds DDT and 6 ounces HETP, significantly lower efficiencies were maintained where the lead arsenate and phenothiazine had been used earlier. Equal results were obtained where tank-mix nicotine bentonite oil formulas were prepared from Mississippi bentonite and either a 14 percent dry concentrate or the 40 percent nicotine sulfate. Both proved superior to a factory-processed fixed nicotine (Niagara experimental formula R-1863).

The addition of HETP had no influence on the efficiency of DDT in codling moth control. The further addition of Triton B-1956 also was of no benefit. When a proprietary deposit builder (Colloidal Products Z-1) was added to DDT and HETP at the rate of 4 ounces per 100 gallons the larvicidal efficiency was improved significantly, as was the DDT residue at harvest.

The Dow acaricide C-726 at 1 pound plus DDT 50 at 1.5 pounds per 100 gallons in the last five sprays significantly improved the efficiency of weathered deposits after mid-season. In another series of tests its use with DDT at 2.5 pounds in two sprays reduced codling moth control.

DDT (technical) when processed with standard lead arsenate at the rate of 6 ounces per 2 pounds in a Bantam Mikropulverizer was as effective as 50 percent DDT and lead arsenate, tank-mixed. Early in the season it was more effective but later it compared less favorably.

Field Testing of Insecticides on Randomized Plots

Small plot tests, in which first-brood and final codling moth and red-banded leaf roller infestation data were obtained from picks and drops, were arranged in four series. Information on the control of the European red mite and the two-spotted spider mite was obtained by taking 100-leaf samples from each variety, at intervals during the season. The brush machine and counting technique developed by C. F. Henderson was used to measure the mite populations. In one series, counts were made at harvest of the San Jose scale infestation on the picks and drops. About 800 trees were used in full season tests and another 100 in shorter tests of acaricides.

Winesap and Jonathan, 2 x 2-tree plots replicated four times: This series was set up to compare the over-all effect of spray programs on all the important local apple pests. The rather complex formulas used are given in Table 2 and the more important data in Table 3.

Table 2. Spray Formulas, Winesap and Jonathan Block, Vincennes, Ind. 1947

All plots were given a dormant spray of 3% oil plus pink and calyx sprays of lead arsenate and sulfur, and a 7-day spray of lead arsenate and Fermate.

Dates of Spray Applications

Calyx	May 7-10	2nd cover ...	June 3-4	5th cover ...	July 25-26
7-day	May 14	3rd cover ...	June 11-12	6th cover ...	Aug. 11-12
1st cover..	May 22-23	4th cover ...	June 25-27	7th cover ...	Aug. 26-28

Plot	Quantities given are for 100 gallons. (DDT actual)
4, 5 to 8	LA 2 lb., DDT 6 oz. + Karbam 1 lb. and 1/2 lb. in sprays 1 and 2
4	DDT 0.75 lb. in sprays 3 to 7. Karbam 2 lb. in spray 4.
8	Same as 4 except TEPP, 2 oz. added to sprays 3 and 4, 3 oz. to 5 & 6.
5	Half strength tank-mix nicotine bentonite (TMNB) 1/2 pt. nic. sul., 4 lb. bent., 2 qt. oil, 6 oz. DDT, 0.5 oz. B-1956 in sprays 3 to 7.
6	Same as 5 except oil reduced to 1 qt. and HETP 4 oz. added to sprays 3 and 4, 6 oz. to 5 and 6.
7	Same as 5 except oil reduced to 1 qt. and TEPP 2 oz. added to sprays 3 and 4, 3 oz. to 5 and 6.
9, 12 to 15, 17	LA 2 lb., DDT 6 oz. in sprays 1 to 4, Karbam 1, 1/2, and 2 lb. in sprays 1, 2 and 4.
9	Same as 6 after 4th cover.
12	DDT 0.75 lb. in sprays 5 to 7 + DN-111, 1.25 lb. in sprays 5 and 6.
13	Same as 12 except HETP 12 oz. substituted for DN-111.
14	Same as 12 except TEPP 6 oz. substituted for DN-111.
15	Same as 12 except parathion 15%, 1 lb. substituted for DN-111.
17	Same as 12 except C-726, 2.5 lb. substituted for DN-111.
	Miscellaneous and Split schedules (change of insecticides after 4th cover)
16	Split LA + DDT. LA 4 lb. in sprays 1 to 4. Bordeaux plus oil in 3 and 4. Same as plot 12 in sprays 5 to 7.
1	Standard TMNB. Nic. sul. 1 pt., Miss. Bent. 8 lb., oil 2 qt. 7 sprays.
2	Split LA + DDT:TMNB (Purdue No. 2, 1946 schedule) LA 3 to 4 lb. in sprays 1 to 4, DDT 1 lb. in 2 and 3, Bordeaux and oil in 3 and 4. Same as plot 1 in sprays 5 to 7.
3	Split LA + DDT:NB + DDT (Illinois 1946 schedule) LA 2 lb., DDT 6 oz. in sprays 1 to 4 + Bordeaux and oil in 3 and 4. Same as plot 5 in sprays 5 to 7.
10	Heavy 1st-brood program. DDT 1 lb., LA 2 lb., HETP 8 oz., Karbam 0.5 to 1 lb. in sprays 1 to 4. Sprays 5 and 6 omitted. DDT 0.75 lb. in spray 7.
11	Same as plot 10 in sprays 1, 3, and 7. Sprays 2, 4, and 6 omitted. DDT 1.5 lb. + parathion 15%, 1 lb. in spray 5.

Table 3. Summary of Combined Winesap and Jonathan Infestation Data. Vincennes, Indiana - 1947.

Plot		Codling Moth				RBLR[1] Injured Apples %	San-Jose[2] Scale %	Average Number of Mites per 100 Leaves	
		Worms/Tree		% Apples					
		July 7	Season	Clean	Wormy			Aug.[3]	Season[4]
LA + DDT in 2 sprays followed by:									
4	DDT	4	357	84	9.0	2.6	10.1	478	506
8	DDT + TEPP	-	160	87	7.1	2.5	7.6	319	308
5	DDT + NB	11	212	86	9.8	1.6	1.0	52	163
6	DDT + NB + HETP	-	118	90	5.6	2.5	8.2	75	170
7	DDT + NB + TEPP	12	278	79	14.4	1.6	0.4	228	286
LA + DDT in 4 sprays followed by:									
9	Same as plot 6	10	440	76	16.4	1.7	7.0	70	242
12	DDT + DN-111	10	213	86	8.8	1.7	3.8	85	339
13	DDT + HETP	10	392	83	10.8	1.3	13.9	250	310
14	DDT + TEPP	10	418	78	12.7	1.3	11.8	560	469
15	DDT + Parathion	10	70	92	2.6	0.9	0.6	40	247
17	DDT + C-726	10	465	77	14.8	1.0	6.0	12	94
Miscellaneous schedules									
16	LA 1st br.:DDT + DN-111	27	205	89	6.6	1.1	0.2	75	223
1	Std. TM Nic. B.	58	361	80	12.2	6.2	0.5	91	176
2	Split LA + 2 DDT + TMNB	7	539	81	14.7	0.8	1.4	177	149
3	Split LA + DDT:NB + DDT	10	486	84	11.6	1.5	3.3	54	62
10	LA + DDT + HETP(5)	1	1231	63	31.7	1.4	24.1	270	422
11	LA + DDT + HETP or Parathion (4)	45	472	79	11.3	1.8	0.6	98	467

1/ Red-banded leaf roller.

2/ Winesap apples infested with scale at harvest.

3/ Average of two 100-leaf samples per plot 7 to 10 days after each of the two principal acaricide sprays.

4/ Average of eight 100-leaf samples taken between July 10 and September 23. Both European red mite and two-spotted spider mites are included.

The trees in this set-up were old and heavily pruned but required an average of 30 gallons spray material each per application. Average yields ranged from 1,500 apples per tree (plot 7) to 3,650 (plots 3 and 11). In 1946 the average number of wormy apples per tree was 350.

Seasonal conditions in 1947 were such that the effectiveness of first-brood spray programs in small plot tests was masked to a far greater extent than normal by the second and third-brood sprays. For example, early in July plot 10 averaged only one worm per tree but its infestation increased 1,231 times by the end of the season while plots 1 and 11, with 58 and 45 first-brood worms per tree, ended the season with only a 6 to 10 times increase.

Lead arsenate used in the first-brood sprays on plot 2 apparently interfered with the efficiency of the nicotine used later so that, despite the use of DDT at 1 pound in two first-brood sprays, the treatment was less effective than plot 1 which had permitted 11 times as many first-brood entrances and was sprayed with the same formula thereafter.

In general, the continued use of lead arsenate at 2 pounds with 6 ounces DDT in the third and fourth covers led to poorer control than where DDT and various supplements were started in the third (plots 9 and 14 vs. 8 and 6 respectively). Treatment 15 was an exception to this. It gave outstanding control because of the inclusion of parathion (15 percent) at 1 pound per 100 gallons (plot 15) in two of the second-brood DDT sprays.

Leaf roller control as a result of the extensive use of lead arsenate was excellent on all plots except No. 1 where the least amount was used. Control was somewhat correlated with the amount of lead arsenate used although parathion (plot 15) seemed to improve it slightly. In 1946 nearly 20 percent of the fruit in this part of the orchard was injured by leaf rollers and the early 1947 attack was far greater than that in early 1946.

The population of San Jose scale crawlers on harvested Winesap apples was apparently affected more by the July 25 spray than any other. The results indicate that HETP and TEPP with DDT (plots 10, 13, 14) affected this insect but little, that parathion (15 percent) in combination with a heavy DDT application (plot 11), 1/2 percent oil with nicotine bentonite (plots 5 and 1), and 1/4 percent oil with nicotine bentonite and TEPP (plot 7) gave excellent control and that HETP with nicotine bentonite (plots 6 and 9) was not very effective. DN-111 as used with DDT on plots 12 and 16 also appeared effective. Observations in 1944 and since indicate that the scale outbreak is not caused directly by the use of DDT. It seems to have been caused more by the omission of summer oil from the spray program and from the use of Speed Sprayers and fixed spray booms for the application of dormant oils. Also, a contributing factor has been the discontinuance of bark removal by growers as a result of the high degree of codling moth control effected by DDT.

Although the mite infestations in this block have been heavy since the first use of DDT in part of it in 1943 the 1947 infestations were too light to cause any visible damage. In 1946, despite the application of a dormant spray and summer acaricides, the average infestation on August 12 was 36 mites per leaf (88 percent Tetranychus bimaculatus (Harvey) and 12 percent Paratetranychus pilosus (C. & F.)). In 1947 the latter made up 91 percent of the population.

The results in these tests indicate that TEPP and HETP were of little value for controlling mites when used in two to four midseason sprays. Possibly this was because the sprays, as spaced for codling moth, were too far apart for effective mite control. However, four applications of HETP at 1/2 pint per 100 gallons (plot 10), with the first-brood sprays more closely spaced, did not prevent an August build-up of P. pilosus. Fair results were obtained where 1/2 percent oil was used with nicotine bentonite and DDT (plots 5, 1 and 3). The best results from two applications of an acaricide were obtained with C-726 at 2.5 pounds (plot 17) and parathion 15 percent 1 pound (plot 15).

No injury to fruit or foliage resulted from any of the programs used in this series of tests. On Jonathan, DDT residues exceeded 7 ppm at harvest on plots 3 and 6. On Winesap the maximum harvest residues of 6.2 ppm were on plot 17. As_2O_3 residues on plot 2 exceeded the tolerance.

Control of a Light Codling Moth Infestation on Rome Beauty: Tests were set up in an 11 x 18 row block of mature trees which had been used for several years for small plot experiments. The area was surrounded by orchard sprayed by the grower and was adjacent to and contained trees on which the red-banded leaf roller destroyed nearly half of the fruit in 1946. Yields since 1943 have averaged between 15 and 25 bushels per tree. The average number of worm entrances per tree in 1944 (when only 20 percent of the trees were sprayed with DDT) was 1,029.

In 1945 and 1946 lead arsenate or nicotine bentonite treatments were used on only about 10 percent of the trees and worm entrances per tree dropped to 76 and 29, respectively.

The 1947 tests were intended to determine how near we could come to annihilation of the pest with DDT in a minimum number of sprays. Three DDT-lead arsenate programs were used on plots containing about one acre each and set up in duplicate. The results in codling moth and leaf roller control are given in Table 4.

Table 4. Control of a Light Codling Moth Infestation and the Red-Banded Leaf Roller with Lead Arsenate-DDT Programs. Vincennes, Ind. - 1947.

Plot	Materials per 100 Gallons in First-Brood Cover Sprays[1]	Worms per Tree	Codling Moth Wormy	Codling Moth Stung	Red-Banded Leaf Roller
		Number	%	%	%
A	Lead arsenate 2 lb. + DDT 50%, 0.75 lb. (4 sprays)	41	0.8	0.7	1.4
B	Lead arsenate 2 lb. + DDT 50%, 3.0 lb. (2 sprays)	21	0.5	1.3	4.6
C	Lead arsenate 2 lb. + DDT 50%, 3.0 lb. (4 sprays)	8	0.2	0.2	1.4
ABC	With ferric dimethyl dithiocarbamate (Karbam)	26	0.5	0.8	3.1
ABC	With weak bordeaux and oil 1/2%	21	0.4	1.0	0.7

1/ On August 13 all plots were sprayed alike with one second-brood application of DDT 50 percent, 1 pound. On one-half of each plot the first-brood sprays included Karbam at 1/2 pound per 100 gallons as a lead arsenate safener. On the other half a 1/2:1:100 Bordeaux mixture plus oil was used.

The 1947 yields were very uniform and averaged 4,300 apples per tree. At the end of first-brood attack only one worm entrance was found in on-the-tree examinations of stratified samples totalling 10,000 apples. The final counts showed that the A program permitted an increase in the infestation above 1946, B about held its own and C reduced the probable carry-over to less than one third of the 1946-47 level. It is important to note that the A program in this set-up was considerably weaker than that used on plot 10, Table 3, where a source of reinfestation resulted in complete failure.

The B program with only two first-brood sprays was divided, alternate rows receiving the sprays at the time of the first and third covers, and the others at the time of the second and fourth. The latter timing was almost twice as effective as the former. Although Karbam or Bordeaux and oil (third and fourth sprays) were equally effective as lead arsenate-DDT supplements from the standpoint of codling moth control, there was a highly significant difference in the control of leaf rollers. As will be shown later, red-banded leaf roller control depended largely upon the amount of lead arsenate residue remaining on the foliage near the end of the season, two months or more after the last lead arsenate spray. The use of oil with lead arsenate strengthened these deposits but the use of four lead arsenate sprays, as on A and C, gave better control than the two used on B. All plots had also been sprayed with lead arsenate in the

pink, calyx and seven-day periods. The use of four times as much DDT on C as on A in the first-brood period had no effect on the final leaf roller infestation.

In 1946 this part of the orchard had infestations of T. bimaculatus which averaged more than 50 per leaf on August 5 and ranged up to 142 on one plot. P. pilosus ranged up to 20 per leaf on the same date.

The average mite infestations (90 percent P. pilosus) on July 14 were as follows:

Plot	Treatment	Mites per 100 Leaves
A - 4 sprays	LA-DDT-Karbam	418
	LA-DDT-Bdx.-oil (in 2 sprays)	130
B - 2 sprays	LA-DDT-Karbam (sprays 1 and 3)	543
	LA-DDT-Karbam (sprays 2 and 4)	554
	LA-DDT-Bdx.-oil (in third)	618
	LA-DDT-Bdx.-oil (in fourth)	84
C - 4 sprays	LA-DDT-Karbam	284
	LA-DDT-oil (in 2 sprays)	30

Since the infestation was predominantly European red mite it was very susceptible to the 1/2 percent oil used with the lead arsenate-DDT-bordeaux mixtures, but its use in the fourth cover had a greater effect than in the third and its use with 1.5 pounds DDT was more effective than with only six ounces.

In 1947 the infestations were observed closely. After they increased to 5 or more per leaf, the first of two applications of 4 acaricides was applied to double rows across the plots so that each first-brood program would be equally represented in each acaricide test. The first spray was applied July 28. DDT was combined with the second acaricide spray on August 13. On August 2, 3, 4, and 5 maximum temperatures ranged from 103 to 104°F. They reached 97° on August 13 and ranged from 94 to 98 between August 16 and 23. The results are given in Table 5.

Table 5. Results of 1.3-Acre Tests of 4 Acaricides on Mature Rome Beauty Trees. Vincennes, Indiana - 1947.

Materials per 100 Gallons and Dates of Application	No. Mites per 100 Leaves July 28 1/	Percent Change in Numbers of Mites from the July 28 counts					
		7/31	8/8	8/15	8/27	9/8	10/1
HETP, 12 fl. oz. on 7/28	575	-99	-88				
8 fl. oz. + DDT on 8/13				-97	-96	+41	-68
DN-111, 1.25 lb. on 7/28	635	-90	-94				
0.75 lb. + DDT on 8/13				-98	-98	+83	-1
Parathion, 0.15 lb. on 7/28	825	-100	-98				
0.09 lb. + DDT on 8/13				-99	-98	-9	-31
C-726, 2.5 lb. on 7/28	423	-99	-99				
1.25 lb. + DDT on 8/13				-99	-99	-82	-34

1/ Samples consisted of 160 leaves from 16 trees per treatment except on August 8 when eight 100-leaf samples were taken from 32 trees per treatment.

Although all acaricides gave excellent results, parathion and, particularly, C-726 had the longest residual effect. The mite infestations on a lead arsenate plot which was set up on five randomized single-tree replicates in this area was 276 on August 15, 480 on August 27 and 872 on September 8.

Despite the high temperatures no injury resulted from the use of the acaricides although some copper injury occurred where bordeaux had been used earlier. This appeared a little more severe in the parathion than the other plots. There was no significant difference in the performance of the acaricides where applied over old lead arsenate-DDT-bordeaux residues as compared to residues of lead arsenate-DDT and Karbam.

Small-Plot Tests on Golden Delicious

The results of tests of various spray programs arranged on three-tree plots each replicated three times are given in Table 6. Infestation data were obtained by making separate on-the-tree and drop counts using approximately 2,100 apples per treatment. The block was uniformly sprayed with lead arsenate and sulfur in the calyx and seven-day sprays. In 1946 it had a moderate codling moth infestation and the red-banded leaf roller damaged 17 percent of the crop.

Table 6. Infestation Data. Golden Delicious. Vincennes, Indiana - 1947

Plot			Codling Moth Injuries/100 Apples On-the-tree Worms	On-the-tree Stings	Drops Worms	RBLR % Inj. Apples	Av. No. Mites per 100 Leaves July, ERM	Aug.Sept. 2-SM
	Sprays 1 to 4	Sprays 5 to 7						
25	LA	TMNB	9.3	6.5	80	0.5	77	782
26	LA + DDT	NB-DDT-oil-TEPP (3 oz.)	1.1	1.6	21	0.4	120	109
27	LA-DDT	DDT + DN-111 (1.25 lb.)	0.7	0.6	27	0.8	55	38
28	LA-Pheno.	DDT + HETP (6 oz.)	2.4	3.1	39	1.1	210	94
	Sprays 1 & 2	Sprays 3 to 7						
29	LA	Niagara fixed nicotine + oil	4.4	5.8	47	0.8	14	47
30	LA	Black Leaf dry concentrate 14% + bentonite + oil	2.7	3.7	43	1.1	36	97
31	LA	Std. TM Nic. bent. + oil	3.9	4.3	48	1.6	86	463
32	LA-DDT	DDT[1/]	1.1	4.2	19	0.7	295	1200
33	LA-DDT	DDT + HT 4 to 6 oz.	1.1	4.2	39	1.1	199	23
34	LA-DDT	No. 33+Colloidal Z-1	0.6	1.9	20	0.4	475	43
35	LA-DDT	No. 33 + B-1956	0.3	3.0	19	0.8	337	76
36	LA-DDT	DDT + C-726, 1 lb.	0.2	1.7	11	0.8	56	47
37	LA-DDT 1 spray. Parathion 15% 4 sprays. Not replicated.		0.8	7.2	1	0	1	27

1/ Four, 8, and 16 ounces of 15 percent parathion were applied to the three replicates in this plot on August 26, two days after the seventh cover spray to check a severe outbreak of mites.

The extra deposits of DDT on plot 34 resulted in serious mite increases after the final spray. The red mite infestation reached 1928 per 100 leaves on this plot September 17 compared to 924 on plot 35 and less than 500 on all others. On August 25 the T. bimaculatus population on two replicates of plot 32 averaged 33 per leaf. Applications of 4 and 8 ounces 15 percent parathion on August 26 reduced these infestations 98.5 and 100 percent, respectively, by August 29. A month after the final spray DDT residues on all DDT plots except 28 exceeded 7 ppm and ranged up to 12.2 ppm on plot 34. As_2O_3 residues exceeded the tolerance on plots 25, 26, 27 and 28, ranging up to 10.6 ppm on plot 25.

Although considerable russet developed in the stem and calyx ends of all apples, the use of lead arsenate in the cover sprays seriously increased russet despite the use of Karbam as a safener. Dow C-726 at 3 pounds per 100 gallons in three sprays caused very severe russet; at 1 pound in five sprays the injury was less severe. It caused no russet on red varieties. Parathion (37) and the lead arsenate-phenothiazine treatment (28) left the best finish on this variety.

Control of Red-Banded Leaf Roller with Lead Arsenate

Tests were set up in 1947 in a Rome Beauty block where 63 percent of the 1946 crop had been injured by red-banded leaf roller larvae and where a tremendous carry-over was present. They were arranged to ascertain the amount of lead arsenate required and the time it should be applied to check a heavy infestation.

Each treatment was applied to three 3 x 3-tree replicates (one acre) with the exception of treatments 5 and 5A. These were applied to 6 and 3 trees per replicate, respectively. The trees were making a vigorous growth and produced an average of approximately 4800 apples per tree. Sprays were applied from tower and ground, inside and out. Data representing all drops and picks from nine trees per treatment are given in Table 7.

Table 7. Control of the Red-Banded Leaf Roller with Lead Arsenate. Vincennes, Indiana - 1947

Plot	Pounds Lead Arsenate (L) and DDT 50% (D) Per 100 Gallons. Spray Numbers and Dates[1]					Percent Injury[2] By Leaf Roller
	Pink 4/28	2 5/27	3 6/6	4 6/17	5 7/3	Apples Season
1	L-3	L-4	L-4	D-1.5	D-1.5	2.2
2	L-3	D-3/4,L-2	D-3/4,L-2	D-1.5	D-1.5	3.4
3	0	Same as Plot 2 after Pink				5.2
4	0	D-3/4,L-2	D-3/4,L-2	D-3/4,L-2	D-3/4,L-2	2.3
5	L-3	D-1.5	D-1.5	D-1.5	D-1.5	12.4
5A		Same as Plot 5 except spray 5			D-3/4,L-4	2.4
6	0	D-1,L-1	D-1,L-1	D-1,L-1	D-1,L-1	3.2
7	Adjacent area sprayed by grower with Speed Sprayer using plot 4 formula but with 1 extra spray inserted.					6.6

1/ All plots were sprayed alike with L-3 in the calyx and first-cover spray on May 7 and 17 and with D-1 on August 28.

2/ The plots averaged 1.2 percent wormy from codling moth.

Poorest results were obtained on plot 5 where lead arsenate was used only in the pink, calyx and first cover sprays and DDT thereafter. Differences between other treatments were small. The use of a Speed Sprayer by the grower gave poorer results than the conventional equipment used to spray the plots, primarily because of insufficient coverage of the lower side of leaves inside the trees.

On May 27 immediately before the second cover spray the average worm population on the foliage was 30 per 1,000 leaves where lead arsenate was used in the pink spray and 34 where it was not. By June 2 these numbers had declined to 10 on plot 1, 13 on plot 5, 20 to 23 on plots 2, 3, and 4 and 28 on plot 6. By late August severe ragging of foliage had developed on plot 5 with only moderate amounts elsewhere. Examinations of 150 leaves on 10 growing points (chiefly terminals) on each of 10 trees per plot on September 19-20, 11 weeks after lead arsenate was last used, yielded 12 larvae per 1,000 leaves on plot 4 and 93 on plot 5. A distinct difference in size of larvae was evident. All instars were present on plot 5 but the larvae found on plot 4 averaged only 3/16 inch in length and none larger than 3/8 inch was found.

Biological Observations on the Red-Banded Leaf Roller

This pest was found to be present in practically all of 27 orchards examined from northern Indiana to west central Tennessee. It was slightly more abundant where DDT was used although all except one grower retained lead arsenate with DDT in some or all first-brood sprays. The excepted orchard at Paducah, Ky., received a straight DDT program after a lead arsenate calyx. By mid-August two generations of leaf rollers had damaged 30 percent of the crop. The final infestation after a heavy third-brood attack was not ascertained but the loss exceeded that experienced with a similar program at Vincennes in 1946.

At Vincennes red-banded leaf roller adults began emerging March 21. The first eggs were laid April 5 and these hatched April 28. The 23 day incubation period continued into the latter part of April but in May it shortened to 16 days for eggs laid April 30. Most eggs were deposited on the lower or vertical surfaces of scaffold limbs. Up to 44 egg masses were found on individual trees. They contained from 20 to nearly 200 eggs each. The larger masses in certain instances were made up of eggs of two ages. The peak of hatch occurred during full bloom between May 4 and 6, inclusive, during which time 39 percent of the masses hatched. All masses that could be foundhatched prior to May 19.

Female moths held under controlled conditions deposited from 42 to 355 eggs each in from 1 to 9 masses. The average deposition per female was 156. At 85°F. the incubation period was seven days compared to five for codling moth.

First-brood adults began emerging June 11 and second-brood by mid-August. As in 1946 larvae were active until the November freezes and some fourth brood hatch could have occurred by mid-October, three weeks before harvest was completed.

Special Tests with Acaricides

The rather low mite infestations in most parts of the principal experimental orchard where DDT was used commercially on 8 acres in 1944 and up to the full 265 acres each year since suggests that a predator complex may be developing which can control mites despite the use of DDT. This of course requires further study.

The low infestation on the principal series of plots made it necessary to set up special tests in midseason where heavy outbreaks were threatened. Some 34 plots were arranged in two orchards, one in which P. pilosus was predominant and one in which T. bimaculatus was most abundant. First-brood lead arsenate-DDT spray programs were used in both orchards.

In all instances the initial infestation on each plot was determined immediately before the first application and at intervals thereafter. Some of the more important results which illustrate the comparative performance of the newer acaricides against the European red mite are given in Table 8.

Table 8. Comparative Effectiveness of Several Miticides Against the European Red Mite on Ben Davis. Vincennes, Indiana - 1947

Plot	Spray Materials - 1 lb. 50% DDT per 100 Gallons Plus:	No. Mites per 100 Leaves on July 18	Percentage Change in Number of Mites from the July 18 Counts			
			July 21	July 29	Aug. 1	Aug. 27
	Sprays applied July 18 and 29					
1	No miticide	312	+47	+335	+206	+109
2	DN-111, 1.25 lb.	432	+3	-64	-74	-62
3	Parathion, 0.15 lb.	1,704	-99	-99	-100	-98
4	Parathion, 0.30 lb.	684	-98	-100	-100	-93
8	Dow C-714, 1 qt.	719	-87	+69	-92	-6
9	Dow C-726, 1.5 lb.	604	-99	-85	-100	-80
10	Dow C-726, 3.0 lb.	660	-99	-97	-100	-97
12	HETP, 6 fl. oz.	592	+11	+315	-89	-73
13	HETP, 12 fl. oz.	576	+57	+203	-99	-92
15	TEPP, 3 fl. oz.	896	-59	+116	-93	-32
16	TEPP, 6 fl. oz.	564	-84	+116	-92	-13
	Sprays applied July 18 only					
5	Parathion, 0.15 lb.	1,408	-99	-100	-100	-99
6	Parathion, 0.30 lb.	1,304	-99	-100	-99	-88
7	Parathion, 0.30 lb. + oil 1 qt.	1,496	-98	-96	-95	-63
11	Dow C-726, 3 lb. + oil 1 qt.	1,040	-97	-98	-100	-87
14	HETP, 12 fl. oz. + oil 1 qt.	548	-99	-58	-50	+108
17	TEPP, 6 fl. oz. + oil 1 qt.	520	-99	-40	+12	+37
	Dusts applied July 18 and 29					
	No DDT included					
	Untreated	776	+43	+93	+148	-30
	TEPP-1% on walnut shell flour	644	-89	-31	-100	-63
	HETP-2% on walnut shell flour	1,604	-91	-80	-99	-91
	Parathion, 1%	800	-95	+142	-97	-62

On plot 1 where DDT alone was used a substantial increase in red mites occurred during the period covered by the experiment. DN-111 did not result in an immediate decrease but before the second spray the population was reduced 64 percent. Control, however, was unsatisfactory. The parathion at two dilutions gave nearly perfect control and showed a very substantial residual effect. The C-714 was relatively ineffective while the C-726 in these tests proved inferior to parathion. The HETP and TEPP showed practically no residual effect hence the heavy egg population resulted in more mites being present before the second spray than the first, however, by timing the second spray closely, 11 days after the first, good commercial control was obtained but not much better than with DN-111. In this experiment the lower concentrations of each material gave practically as good results as twice that quantity. Single applications of parathion (plots 5 and 6) gave as good results as two applications. The addition of 1/4 percent oil did not improve parathion or C-726 but did aid HETP and TEPP. However, this effect here may have resulted from the enhanced acaricidal properties of oil when used with DDT, as has been reported in previous years.

Two dust applications were made on some of the plots shown in Table 8. Since no DDT was included with the dusts, DDT residues were lower than on the sprayed plots and the rate of increase of the mites may have been retarded in part by greater predatory activity. However, the infestations on the untreated plot indicate that the materials had a substantial residual as well as immediate toxicity. The HETP and TEPP dusts were prepared immediately before use in a self mixing duster. The diluent was walnut shell flour and the toxicant per tree amounted to less than 1/3 that used on the spray plots. The 1 percent parathion dust in these tests was less effective than the freshly made TEPP and HETP dusts.

The results of certain tests against T. bimaculatus are given in Table 9. The infestation on these Golden Delicious trees was rapidly increasing at the time of the first application.

Table 9. Comparative Effectiveness of Certain New Acaricides Against the Two-Spotted Spider Mite on Golden Delicious. Vincennes, Ind. 1947

Materials per 100 Gallons Plus DDT 50%, 1 lb.1/	Mites per 100 Leaves		Percentage Change in Number of Mites from the Aug. 12 Counts			
	Aug. 4	Aug. 12	Aug. 14	Aug. 25	Aug. 29	Sept. 17
DDT alone	1,304	6,544	-50	-29	-92	-100
DN-111, 1 lb.	1,568	4,928	-90	-99	-99	-100
Dow C-714, 1 qt.	932	3,808	-96	-52	-99	-100
Dow C-726, 2 lb.	1,048	5,120	-94	-97	-100	-100
Parathion, 25%, 0.75 lb.	3,728	5,996	-95	-99	-100	-100
Parathion, 15%, 1.25 lb.	4,320	7,808	-99	-100	-100	-100
HETP (Victor), 10 fl. oz.	4,048	5,536	-100	-63	-99	-100
IN-4200 (DuPont), 1 pt.	2,256	4,304	-71	-68	-99	-99

1/ Sprays were applied August 12 and 26.

Sprays were applied from tower and ground at 600 pounds pressure. Because of the webbing spun by this species of mite, especially after a heavy infestation develops, many mites were washed off with their webbing by the force of the sprays. Another reason for the decline on the DDT plot was the heavy damage by the mites between August 12 and 25 which resulted in a short food supply and forced early hibernation. However, the August 25 population on the DDT plot was still 4,656 mites per 100 leaves and on the HETP plot 2,048 per 100 leaves compared to 54 and 65 respectively on the DN-111 and parathion (25 percent) plots.

Parathion at approximately 0.19 pound per 100 gallons was outstanding in these tests. IN-4200, an organic sulfide, was less effective than HETP. As reported in 1946, DN-111 is much more effective against this species than against P. pilosus.

Toxicity of New Materials to Spraymen

Hexaethyl tetraphosphate and tetraethyl pyrophosphate sprays, when they come in contact with the eyes, have caused a serious contraction of the pupils which has greatly reduced vision under artificial light. The effect may persist for several days. Some workers have noted an interference with breathing. The parathion, as a wettable powder, has had no adverse effect on our spraymen.

Results of Orchard Surveys

Surveys at monthly intervals from June to September, inclusive, were made to determine the mite infestations on three varieties per orchard in 27 orchards distributed from the Michigan line to west central Tennessee.

As in 1946 T. bimaculatus or a closely related new species was found in all orchards. The new species was present in at least 15. It was identified by E. A. McGregor and was reported by him to be more nearly like T. schoenei than T. bimaculatus. Infestations of the two-spotted mite ranged up to 105 per leaf at both the northern and southern limits of the area surveyed. Likewise P. pilosus ranged up to 100 per leaf in one west central Indiana orchard (in July), 57 at Vincennes (in July), 33 at Henderson, Ky. (in June), 35 at Fulton, Ky. (in August), and 37 at Jackson, Tenn. (in July). P. pilosus was found in all except two orchards and appeared during 1947 in five western Kentucky, eastern Illinois, and southwestern Indiana orchards where it was not found in 1946. HETP was used by one-third of the growers to check mites. Others relied on DN-111, oil, or rotenone sprays.

Throughout the range of territory covered, mite infestations of all species of mites averaged much higher in DDT than non-DDT sprayed orchards.

BELTSVILLE, MARYLAND

E. H. Siegler, In Charge

Laboratory Experiments with Insecticides for Codling Moth

The number of synthetic organic compounds tested under laboratory conditions by means of the apple-plug method was limited by the scarcity of codling moth stock. Of the compounds tested, none was promising with the exception of parathion. Benzene hexachloride (gamma isomer 12 percent) 4-100 was again found very much less toxic than DDT 3/4-100. An emulsion containing 40 percent of chlordane at dosages of 2-100 and 4-100 was highly ineffective.

Laboratory Investigations of Miticides

The outstanding compound tested against the two-spotted mite, Tetranychus bimaculatus (Harvey), on lima beans under greenhouse conditions was parathion. This compound was sprayed on plants at a dosage of 0.4 pound in 100 gallons of 20 percent ethanol solution. Under conditions of very heavy mite abundance, the sprayed plants were well protected for about two weeks except on the new growth that developed during the period.

In a residual test against the two-spotted mite under greenhouse conditions, a mixture of parathion and DDT extended plant protection for a few days beyond that obtained with parathion alone.

Laboratory Investigations of Aphidicides

Parathion was highly effective in laboratory tests against the cabbage aphid, Brevicoryne brassicae (L.), as evaluated by means of the leaf-disk technique. During a period of over 10 weeks a mixture of parathion, at the rate of 1 part to 40,000 parts of a water solution of Dreft (1-10,000), was tested from time to time. Each test resulted in practically complete kill of the aphid. It is apparent from these results that parathion is very stable in water containing a very small amount of Dreft as a wetting agent.

POUGHKEEPSIE, NEW YORK

D. W. Hamilton, Bureau of Entomology and Plant Quarantine, Agricultural Research Administration, U. S. Department of Agriculture, and J. L. Brann, Jr., New York Agricultural Experiment Station.

These investigations were carried on jointly by the U. S. Bureau of Entomology and Plant Quarantine and the New York State Agricultural Experiment Station at the Hudson Valley Fruit Investigations Laboratory, Poughkeepsie, N. Y.

Except for a few instances codling moth injury in 1947 in the Hudson River Valley was of minor importance in commercial orchards. Injury where adequate control was not obtained could be traced to poor timing, stretching of intervals between application, or the discontinuance of protective sprays too early in the season. Pupation was first observed May 2 and adults were first taken in the bait traps May 25 with peak first brood captures occurring between June 6 and 12. Entries in the fruit were first found June 12 which is several days later than the average for this locality. First brood moths began emerging under insectary conditions July 23, whereas emergence under similar conditions has occurred as early as July 4. Weather conditions throughout August were ideal for first brood moth activity and second brood larval entries but in commercial plantings codling moth injury was comparatively light. Peak of the injury occurring took place between August 14 and 28, a week or so later than average. Carry-over of larvae into 1948 continues to be light.

Field Tests of Insecticides

Spray Experiments - Trapani Orchard, Latintown, N. Y.

McIntosh Block: Eleven plots on large single trees replicated five times were located in this block. Sprays compared consisted of varying concentrations of 50 percent wettable DDT, 50 percent wettable DDT at delayed intervals, commercial emulsible sprays containing 25 percent DDT, lead arsenate and 15 percent powdered parathion. One plot received no insecticides during the season.

The precodling moth treatment of this block applied primarily for the control of scab, which was severe in this orchard, was as follows. Materials are for 100 gallons.

May 2 .... Dust - micronized sulfur
May 6 .... Spray - micronized sulfur 8 pounds
May 13 .... Spray - Puratized 1 pint
May 23 .... (Calyx) Spray - Puratized 1 pint and lead arsenate 3 pounds
May 30 .... (Curculio) Spray - lead arsenate 3 pounds, lime 3 pounds, and micronized sulfur 8 pounds.

The following fungicides were included with the insecticides applied in the cover sprays and were applied alone to plot 1. Amounts are for 100 gallons.

First cover ..... Micronized sulfur 8 pounds
Second cover ..... Micronized sulfur 6 pounds
Third and Fourth covers ..... 2,3-dichloro-1, 4-naphthoquinone (Phygon) 1/2 pound and micronized sulfur 3 pounds.

Except for plot 3, five cover sprays were applied during the season, four during first brood activity and one during second brood activity. Control would have been improved in most instances had a sixth cover been applied about 10 days after the fifth, as the peak of second brood activity occurred at a relatively late date in August and codling moth populations in this orchard were heavier than those in the average commercial orchard. Dates of applications for the cover sprays on all plots except number 3 were June 12, 23, July 2, 14, and August 12. Cover sprays were applied to plot 3/ on June 12, 26, July 14, and August 12.

Results obtained are presented in the infestation records in Table 1.

Table 1. Infestation Records - 1947. B. Trapani Orchard, Milton, N. Y.
Variety - McIntosh

Replicated five times, except plot 1 which is replicated three times. Five covers except plots 1 and 3. Three received 3 first brood covers at stretched intervals and 1 second brood cover.

	Plot and Treatment (Pounds per 100 Gallons)	No. Apples Per Tree	Apples Clean %	Average Number per 100 Apples		Av. No. Worms per Tree
				Worms	Stings	
1	No insecticide	1705	57.7	63.2	8.1	1441
2	50% DDT (Deenate 50-W) 2 lb.	1600	97.2	1.6	1.3	31
3	50% DDT (Deenate 50-W) 2 lb. - 4 cov. (at stretched intervals)	1692	95.2	3.8	1.7	68
4	50% DDT (Deenate 50-W) 1.5 lb.	1456	92.9	6.5	2.5	90
5	50% DDT (Deenate 50-W) 1 lb.	1686	89.6	10.3	1.5	163
6	25% DDT emul. in Glycol (G.L.F. Fruit Spray No. 12) 1 pt.	2545	87.4	10.0	4.5	254
7	25% DDT emul. (Geigy E-25) 1 qt.	1815	90.2	8.7	3.5	167
8	50% DDT (Deenate 50-W) 2 lb. - 4 cov. 1 lb. - 5th cov.	1673	95.4	3.5	1.8	65
9	Lead arsenate (Grasselli) 3 lb.	1490	81.8	9.5	18.4	147
10	15% Parathion (American Cyanamide Co. 3422) 2 lb. - 1 cover 3 lb. - 2 to 5 covers	1484	96.2	2.5	1.7	32

The control of codling moth obtained with parathion, plot 10, seems of special interest since it approached that obtained by the use of DDT, plot 2, and was superior to that obtained with lead arsenate, plot 9. Determinations of parathion present on fruit picked September 11 from plot 10 were made by P. R. Averell of the American Cyanamid Company and averaged less than 0.2 ppm green weight. Prior to using Phygon with the parathion no injury occurred to the fruit or foliage. When parathion was combined with Phygon, circling and cracking occurred at the point of run-off on at least 50 percent of the fruit. This injury was attributed to the presence of Phygon.

Data obtained relative to the concentration of DDT needed for 100 gallons of spray, plots 2, 4, and 5, continue to indicate that where codling moth activity is severe, one pound actual DDT per 100 gallons of spray is generally needed, although 3/4 pound actual DDT may be sufficient in lightly infested orchards where applications were made over a large area and the fruit is not subject to reinfestation from poorly protected trees nearby as in the instance of these plots.

Severe burning of the foliage occurred in the instance of plot 6 and fruit drop seemed to increase on this plot. In plot 7 there was a moderate amount of burning to the foliage. In some instances fruit from these plots was injured at the point of run-off. This injury may have been caused partially by the presence of Phygon used as a fungicide. The most severe burning occurred after the application of the fifth cover spray.

Omission of one DDT cover spray during first brood activity and stretching out the interval between applications, plot 3, reduced control obtained, plot 2. However, worms per 100 were less than where the five cover spray program was carried through at a lower dosage of DDT, plot 4.

Delicious Block: Ten plots replicated three times, except for the unsprayed plot, were maintained in this block which was adjacent to the McIntosh block. Trees were of medium size.

The purpose of the experiment was to study the effect of summer type oils used in conjunction with DDT and to determine the comparative safeness of summer oils with bases that were predominately paraffinic, naphthenic or heavy naphthenic when used in conjunction with DDT. Fermate was included in the schedule as needed for control of scab. Oils and DDT sprays containing oil were supplied by the Shell Oil Company.

The precodling moth treatment of this block, applied primarily for the control of scab, was the same as that listed for the McIntosh block except that Fermate, 2 pounds/100 gallons, was substituted for the micronized sulfur in the May 30 application.

Except where listed otherwise in Table 2, five cover sprays were applied to these plots on the same dates as listed for the McIntosh block. Results of infestation records taken are shown in Table 2.

Table 2. Infestation Records - Insecticide Plots - 1947
B. Trapani Orchard, Milton, N. Y. Variety - Delicious

Replicated three times except plot 11 which is one tree only.
Fungicide used - Ferric dimethyl dithio carbamate (Fermate)
First cover 2 pounds, second + third covers 1 pound, fourth 1/2 pound

	Plot and Treatment (Amount per 100 Gallons)	Number Apples per Tree	Apples Clean %	Drops to 3/ July 2 %	Average per 100 Apples		Average No. Worms per tree
					Worms	Stings	
11	No insecticide (one tree)	1451	59.0	0.8	41.9	51.2	603
12	ShellACX-147 DDT emulsion (Resitox D-25) 1 qt.	807	86.9	1.4	5.9	14.2	37
13	Shell ACX-155 (25% DDT emulsion) 1 qt.	2390	78.2	3.8	12.2	22.8	262
14	Shell ACX-177 (pred. paraffinic oil + 0.25 lb. DDT/1 gal.) 1 gal.	1600	83.3	17.9	3.0	21.3	39
15	Shell ACX-178 (pred. naphthenic oil + 0.25 lb. DDT/1 gal.) 1 gal.	1626	86.0	26.7	5.5	16.0	67
16 1/	Shell ACX-179 (pred. heavy naphthenic oil + 0.25 DDT/1 gal.) 1 gal.	1061	82.1	65.4	12.0	16.0	46
17 2/	Shell ACX-174 (pred. paraffinic oil) 1 gal. 50% DDT (Deenate 50W) 1 lb.	1100	85.2	5.8	6.3	14.3	65
18	Shell ACX-175 (pred. naphthenic oil) 1 gal. 50% DDT (Deenate 50W) 1 lb.	1207	89.2	16.6	2.6	12.9	29
19 1/	Shell ACX-176 (pred. heavy naphthenic oil) 1 gal. 50% DDT (Deenate 50W) 1 lb.	1121	85.9	68.6	8.2	10.7	33
20	50% DDT (Deenate 50W) 1 lb.	1119	88.6	2.1	2.6	13.7	29

1/ Received three cover sprays only due to lack of fruit resulting from heavy early drop.

2/ Fifth cover spray omitted due to lack of material. All other plots received 5 covers.

3/ Not used in analyses of injury.

Examinations made on the Delicious plots June 26 following the second cover spray showed that a heavy drop of fruit and leaves had occurred on plots 16 and 19. Leaf drop was moderate on plots 14, 17 and 18, and light on plot 15. No leaf drop was apparent on plots 11, 12, 13, and 20. The percent of the crop dropped early in the season was determined on July 2 for all plots. Results obtained confirm those reported in 1945 and 1946 and show that summer oil and DDT should not be used together. The heaviest drop occurred on plots 16 and 19 where oil used with DDT was predominately a heavy naphthenic base. Drop on plots 17 and 27, where predominately naphthenic base oils were used, was much greater than on plots 14 and 17, where predominately paraffinic base oils were used, providing the same amount and type of DDT was used.

Large Scale DDT Spray Experiments Applied by Growers

Two large scale DDT spray experiments applied by growers were observed for a third season. Both the Clarke and the Hubbard orchards had dormant oil applications during 1947. Two-spotted spider mite, Tetranychus sp., populations were especially severe in the Clarke orchard during late August, and the grower applied a spray containing hexaethyl tetraphosphate on August 28. Light infestations of red-banded leaf roller were present in both the Clarke and Hubbard orchards in 1947. Infestation records for both codling moth and red-banded leaf roller are shown in Table 3 for the Clarke orchard and Table 4 for the Hubbard orchard. Adults captured in bait traps during the past three years are shown by months in Table 5 for both orchards.

Table 3. Infestation Records, Large Scale Grower Experiment, 1945-47
J. R. Clarke & Sons Orchard, Milton, N. Y. Variety, McIntosh

Average six trees. Material used DDT (25%) 4 pounds/100 gallons 1945, DDT (50%) two pounds/100 1946-1947.

Year	No. Covers	Number Apples per Tree	Apples Clean %	Average Number Apples per 100 Apples		Av. No. Worms per Tree	Injured by Red-Banded Leaf Roller Percent
				Worms	Stings		
1947	3 -- 1st brood	5068	99.2	0.1	0.9	8.5	4.7
1946	4 -- 1st brood	1528	99.6	0.1	0.4	1.8	--
1945	4 -- 1st brood						
	1 -- 2nd brood	2382	97.6	0.1	2.5	2.8	--

Lead arsenate (3 pounds per 100 gallons) included in first covers in 1946 and 1947.

Table 4. Infestation Records, Large Scale Grower Experiment, 1945-47
E. S. Hubbard & Sons Orchard, Poughkeepsie, N. Y.

Average six trees McIntosh 1945-46. Three trees Cortland 1947. Sprays DDT (25%) 4 pounds/100 gallons 1945, DDT (50%) 2 pounds/100 gallons 1946-47. Dusts DDT 5%.

Year	Block and Treatment	Number Apples per Tree	Apples Clean %	Average Number per 100 Apples Worms	Stings	Av. No. Worms per Tree	Injured by Red-Banded Leaf Roller Percent
	Block A - DDT - 3 years						
1947	2 sprays + 1 dust 1st brood 1 dust 2nd brood	2929	93.6	1.4	6.3	37.0	5.4
1946	3 sprays 1st brood, 1 dust 2nd brood	5472	98.1	1.1	0.9	64.0	--
1945	4 sprays 1st brood 2 sprays 2nd brood	1943	95.3	1.2	4.7	24.5	--
	Block B - DDT - 2 years						
1947	Same as Block A	2879	92.7	3.2	6.4	96.3	6.9
1946	Same as Block A	3045	93.1	5.6	2.4	152.0	--
1945	LA[1]/ - 3 lb., lime 3 lb., NS-1/2 pt., 1st & 2nd covers Phenothiazine 2 lb., 3rd cover. LA - 3 lb., lime 3 lb., 4th cover. NS-1/2 pt., summer oil 2 qt., 5th & 6th covers.	1952	59.8	28.3	41.5	560.0	--

1/ LA= lead arsenate. NS=nicotine sulfate. Amounts per 100 gallons. Lead arsenate included in first covers in 1946 and 1947.

Table 5. Codling Moth Bait Trap Captures. Large Scale DDT Tests 1945-47.
Five Traps

Orchard and Treatment	Total Adults Captured Year	May	June	July	Aug.	Total
Clarke						
5 sprays DDT	1945	1024	219	72	13	1328
4 sprays DDT	1946	48	72	1	2	123
3 sprays DDT	1947	3	35	0	0	38
Hubbard - Block A						
6 sprays DDT	1945	1015	263	30	13	1321
3 sprays DDT + 1 dust DDT	1946	127	85	1	13	236
2 sprays DDT + 2 dusts DDT	1947	29	156	0	2	187
Hubbard - Block B						
6 sprays LA-Nic.-phenothiazine	1945	264	285	43	25	617
3 sprays DDT + 1 dust DDT	1946	50	75	20	26	171
2 sprays DDT + 2 dusts DDT	1947	13	76	1	1	91

Dust and Mist Spray Experiments

Field plots, comparing control of codling moth obtained with conventional sprays, mist sprays, and wet and dry dusts were maintained throughout the season in the J. S. Hand orchard, Stuyvesant Falls, N. Y. Principal varieties present were McIntosh and Cortland. All plots were replicated three times with each replicate containing at least five trees.

Applications for codling moth control were started between June 14 and 16. Conventional sprays were applied with a Bean Royal 35 gallon per minute pump with a single nozzle gun with pressure at 600 pounds at the pump, and the gun orifice 5/32 inches. All mist sprays, except on plot 13, were applied with a laboratory constructed mist sprayer consisting of a Niagara Direct Drive orchard duster and a Bean 4 gallon per minute pump. The spray was injected into the air blast at the end of the dust outlet nozzle through a special devised nozzle developed by J. L. Brann, Jr. Pump pressures used were about 200 pounds. The dusts were applied with a Niagara cyclone wet duster equipped with a positive feed. Generally the mist sprays were applied between 8:30 and 11:00 p.m. and the dusts between 4:30 and 8:00 a.m. The equipment was driven at the rate of about 2 miles per hour.

Type of application, materials used, concentration, and rate of application per tree are shown in Table 6. Special dust applications of micronized sulfur were applied to all plots for scab protection on June 24, July 8, 19, and 22. D-4 dust was applied to all plots in order to reduce a heavy infestation of European red mite on July 18. Dates of application for the codling moth protection were:

Plot 1	June 15, 24, July 3, 16, and August 14. 5 covers.
Plot 8	June 16, 24, July 3, 17, and August 15. 5 covers.
Plots 2, 3, 4, 5, 6, 7 and 9	June 16, 24, July 1, 8, 17, and August 15. 6 covers.
Plots 10, 11, 12, 13 and 14	June 15, 24, 30, July 7, 16, and August 14. 6 covers.

Table 6. Codling Moth Dust and Mist Spray Experiment - 1947
J. S. Hand Orchard, Stuyvesant Falls, N. Y.
Varieties: McIntosh and Cortland

Plot No.	Type of Application	Material Used	Concentration	Rate per Tree
1	Conventional Spray	50% DDT Powder (Deenate 50-W)	2 lb./100 gal.	15 gal.
2	Dust	5% DDT plus 2% oil (100 vis.)		1 lb.
3	Dust	7-1/2% DDT plus 2% oil (100 vis.)		1 lb.
4	Dust	5% DDT without oil		1 lb.
5	Dust	5% DDT plus 2% oil (60-65 vis.)		1 lb.
6	Dust	5% DDT plus 4% Colloidal Sticker		1 lb.
7	Wet Dust	5% DDT without oil		1 lb.
		Dustix (Niagara)	1-1/2 pt./100 gal.	1/3 gal.
8	Dust	5% DDT plus oil (100 vis.)	At 10 day intervals	1 lb.
9	Dust	20% DDT plus 2% oil (100 vis.)		4 oz.
10	Mist Spray	75% DuPont DDT wettable powder	37-1/2 lb/100 gal.	1 qt.
11	Mist Spray	75% DuPont DDT wettable powder	18-3/4 lb/100 gal.	2 qt.
12	Mist Spray	30% DDT in solvent (Syndeet 30)	12-1/2 gal/100 gal.	1 qt.
13	Mist Spray	1 lb. DDT per gal. of a 50-50 mixture of G.L.F. No. 12 base and kerosene - 1st to 4th covers 25% of the DDT mixture applied with 75% water at the rate of 1 qt. per tree was used in the 5th and 6th covers.		1 pt.
14	Mist Spray	25% DDT in solvent (Gesarol E 25)	15 gal/100 gal.	1 qt.

Careful visual observations and infestation records taken from McIntosh trees in two of the plots showed that in all instances differences in codling moth infestations were greater within plots than between plots and that the differences in infestations between plots were not significant. For example, worms per 100 apples in plot 4 averaged 1.0 as compared to 1.3 for plot 11. Injury in the form of burning on the foliage occurred in plot 13 to such an extent that kerosene was discontinued for use as the carrier. Occasional burning also occurred on

the foliage of trees in plot 14. Mist sprays offer considerable promise for the future control of codling moth and further work of this type of application is contemplated. To date the most practical formulations tested for mist sprays are those used on plots 10 and 11 which consist of 75 percent wettable DDT at the rate of 6 ounces to 1 gallon of water applied at 1 quart per tree, or 3 ounces to 1 gallon of water applied at 2 quarts per tree. Samples of apples for residue analyses were taken from these plots before and after each application. Analyses for DDT are being made from these samples by A. W. Avens of the New York Agricultural Experiment Station and it is anticipated that the results of these findings will give valuable information relative to the initial deposits and rate of weathering of the various types of dusts and mist sprays used.

Orchard Mites - Poughkeepsie, New York, 1947.

R. W. Dean, New York Agricultural Experiment Station

Overwintering eggs of the European red mite were very abundant in a few orchards but were not numerous in most. There was some build-up of mites in late June and early July but no outbreak such as occurred in 1946. Late-season infestations by this species were rare.

Large numbers of overwintering two-spotted spider mites were found in several orchards but, as in the previous spring, the mites on the trees died out about the time that bud development started. Later infestations developed from migrants from the orchard ground cover. The earliest noted infestation developed during late spring but this was an exception. Many DDT-sprayed orchards became heavily infested in mid- or late summer and damage was more widespread and severe than in any previous year.

Ovicidal tests on European red mite are shown in Table 1. Dormant applications of DN-289 at 2 to 3 quarts per 100 offer promise for combined red mite - aphis control. Superior type oil in the delayed dormant spray gave slightly better control than regular type oil but the difference was not significant. Both, however, were significantly better than highly naphthenic oil in these tests. Prepink applications of 2 percent oils were effective with no significant difference between a 58-64 second viscosity oil and a 100-105 second viscosity oil.

Materials applied in the pink or calyx spray to supplement delayed dormant oil sprays are shown in Table 2. Results are based on the numbers of European red mite eggs present on the foliage on July 1. This was necessary since the two-spotted mite had built up to a high level and counts of less readily distinguishable stages were impractical. Neither dichlorophenyl ethane (C-420) or hexaethyl tetraphosphate applied

at the pink stage increased control obtained from the delayed dormant oil alone. Hexaethyl tetraphosphate in the calyx spray apparently reduced red mite almost as much as the oil spray.

Treatments applied for summer control were directed primarily against the European red mite but an infestation of two-spotted mite developed later so that data taken include counts on both species. The European red mite was the dominant species until September when the two-spotted mite became most numerous.

The tests started with a 3 percent oil application to half of each plot in the delayed dormant spray. Later treatments started with the second cover spray and continued through the fifth cover spray. The schedules followed are shown in Table 3. Population counts were made at 10 to 14 day intervals from June 25, the day before the first differential treatments were applied, until September 29. Samples of 25 leaves from each of four trees per plot were brushed and the mites and eggs counted.

Where no further acaricidal treatments were used (plots 1 and 2), the oil delayed development of peak mite populations 20 to 23 days and reduced them to one-half or one-fourth the size of peak numbers on unoiled trees.

The lowest average mite populations developed in plots 4 and 5 and that in plot 4 was also the lowest in proportion to the initial population. The initial population in plot 5 being lower, the percentage of it represented by the average population after treatment started is higher.

The second-lowest populations were found in plots 6 and 8, where hexaethyl tetraphosphate was used. Plot 6 shows a relatively greater reduction over the initial population because of the latter's size. Plot 8, with a low initial population shows much less reduction on a percentage basis.

In plot 3, C-714 was shown to be not very effective and this is further indicated in plot 7 where C-714 at half-strength was combined with an effective acaricide, C-728, also at half-strength.

Plots 1 and 2 did not receive an acaricidal treatment other than the delayed dormant oil application to half the tree. The percentage difference between the two is due to the difference between initial populations since the average numbers of mites and eggs during the treatment period do not differ greatly.

Predators, especially Stethorus, were numerous before the first cover spray, which was applied by the grower. They were not observed after that.

Slight foliage injury developed in plot 5 after the second cover spray was applied, succeeding temperatures having been high. It did not become serious on the leaves and did not involve the fruit. None of the other materials tested caused injury to the two varieties, Wealthy and Red Delicious, in the test block.

Table 1. Ovicidal Tests on European Red Mite Eggs

Materials Used per 100 Gallons	Time of Application	Percent Control
DN-289 3 qt.	Dormant	99.06
DN-289 2 qt.	Dormant	97.65
DN-289 1 qt.	Dormant	91.86
Superior (Paraffinic) Oil 3 gal. Bordo 2-4-100	Delayed Dormant	100.00
Regular (Intermediate) Oil 3 gal. Bordo 2-4-100	Delayed Dormant	97.87
Highly Naphthenic Oil 3 gal. Bordo 2-4-100	Delayed Dormant	94.67
58-64 Sec. Oil 2 gal. Fermate 1-1/2 lb. B-1956 76 cc.	Prepink	98.58
100-105 Sec. Oil 2 gal. Fermate 1-1/2 lb. B-1956 76 cc.	Prepink	99.21

Table 2. Prepink and Calyx Sprays for European Red Mite Control

Materials Used per 100 Gallons	Time of Application	Number Eggs/25 Leaves	Percent Difference from Check
Superior Oil 3 gal. Bordo 2-4-100	Delayed Dormant	2.3	-99.78
Superior Oil 3 gal. Bordo 2-4-100 Dichlorophenyl ethane 1 qt. Wettable Sulfur 6 lb.	Delayed Dormant Pink	38.8	-96.17
Dichlorophenyl ethane 1 qt. Wettable Sulfur 6 lb.	Pink	544.8	-46.11
Superior Oil 3 gal. Bordo 2-4-100 50% Hexaethyl tetraphosphate 1 pt. Wettable Sulfur 6 lb.	Delayed Dormant Pink	11.3	-98.89
50% Hexzethyl tetraphosphate 1 pt. Wettable Sulfur 6 lb.	Pink	48.3	-95.23
50% Hexaethyl tetraphosphate 1 pt. Wettable Sulfur 6 lb. Lead Arsenate 3 lb.	Calyx	15.5	-98.47
Check		1010.8	-----

Table 3. Summer Control of Orchard Mites

Plot No.	Materials Used per 100 Gallons					Average Number of Mites and Eggs per Leaf		% of June 25 Population Represented by July 2-Sept. 29 Average
	1st Cover June 16	2nd Cover June 26	3rd Cover July 7	4th Cover July 18	5th Cover Aug. 7	June 25	July 2-Sept. 29	
1	DDT 2# Lead Ars. 3# Lime 3# Wet. Sul. 6#	DDT 2# Wet. Sul. 6#	DDT 2# Wet. Sul. 6#	DDT 2# Wet. Sul. 5#	DDT 2#	12.50	21.29	170.32
2	As above	Lead Ars. 3# Lime 3# Wet. Sul. 6#	Lead Ars. 3# Lime 3# Wet. Sul. 6#	Lead Ars. 3# Lime 3# Wet. Sul. 5#		27.79	24.20	87.08
3	As above	DDT 2# C-714 1 qt. Wet. Sul. 6#	DDT 2# C-714 1 qt. Wet. Sul. 6#	DDT 2# Wet. Sul. 5#	C-714 1 qt.	22.20	17.93	80.76
4	As above	DDT 2# C-726 2-1/2# Wet. Sul. 6#	DDT 2# C-726 2-1/2# Wet. Sul. 6#	As above	C-726 2-1/2#	29.23	4.75	16.25
5	As above	DDT 2# DN-111 1-1/4# Wet. Sul. 6#	DDT 2# DN-111 1-1/4# Wet. Sul. 6#	As above	DN-111 1-1/4#	18.43	4.61	25.01
6	As above	DDT 2# 50% HETP 1 pt. Wet. Sul. 6#	DDT 2# 50% HEPT 1 pt. Wet. Sul. 6#	As above	50% HETP 1 pt.	45.78	7.57	16.53
7	As above	DDT 2# C-714 1 pt.1/ Wet. Sul. 6#	DDT 2# C-714 1 pt.1/ Wet. Sul. 6#	As above	C-714 1 pt. C-726 1-1/4#	33.55	12.41	36.99
8	As above	DDT 2# 100% HETP 1/2 pt. Wet. Sul. 6#	DDT 2# 100% HETP 1/2 pt. Wet. Sul. 6#	As above	100% HETP 1/2 pt.	18.11	6.62	36.55

1/ Also C-726 1-1/4 lb.

Apple Maggot Investigations - Poughkeepsie, New York - 1947

R. W. Dean, New York Agricultural Experiment Station in Cooperation with the U. S. Bureau of Entomology and Plant Quarantine.

Late emergence of flies made control of apple maggot difficult in most orchards and particularly so in those subject to migration of flies from nearby unsprayed apple trees, fence rows or woods. Emergence started June 19, approximately four days later than the average, and the peak occurred July 23, about seven days later than the average. Continuous emergence lasted until August 15 and intermittent emergence until September 2-3.

None of the programs tested gave adequate control. One orchard was dusted five times with 3 percent DDT dust at seven-day intervals from June 27 to July 24, and again on August 5 and August 15. The estimated degree of fruit infestation in 1946 was nearly 100 percent. A very conservative estimate of all varieties is 75 percent. Infestation records based on examination of all fruits from six trees are shown in Table 1 for 1947.

Table 1. Apple Maggot Infestation Records from DDT Dusted Orchard 1947

Tree	Variety	No. Apples	Percent Infested
1	Wealthy	4984	82.4
2	R. I. Greening	1998	27.7
3	McIntosh	1968	31.8
4	Wealthy	2798	52.8
5	McIntosh	2340	33.5
6	Baldwin	3184	70.3
	Total	17,272	Average 49.8

Besides having an initially high infestation, this orchard was subject to fly migration from an adjoining unsprayed apple and plum orchard which, in 1947, had only a light crop of plums and no apples. This probably induced a heavy movement of flies seeking fruit in which to lay eggs.

Another test block was sprayed with 50 percent DDT wettable powder 2 pounds per 100 plus wettable sulfur on June 24 and 26 (second cover), July 9 (third cover) and July 21 (fourth cover). The fourth cover spray also contained lead arsenate 3 pounds per 100 and hydrated lime 3 pounds per 100. Infestation counts based on examination of all fruit from four trees are shown in Table 2.

Table 2. Apple Maggot Infestation Records from DDT Plus Lead Arsenate Sprayed Orchard - 1947

Tree	Variety		No. Apples		Percent Infested
1	McIntosh		2763		71.8
2	McIntosh		2890		59.4
3	Baldwin		2214		33.1
4	Baldwin		1981		64.1
		Total	9848	Average	57.1

The average infestation in the same trees in 1946 was 36.3 percent. This orchard is not near any known unsprayed apple trees but is surrounded on two sides by woods. The borders of the woods were sprayed. Apparently, even the inclusion of lead arsenate in the fourth cover spray failed to continue protection late enough in the season.

A third orchard was sprayed with 50 percent chlordane wettable powder 2 pounds per 100 on June 23 (second cover), July 5 (third cover), July 16 (fourth cover) and August 4 (fifth cover).

Infestation records for all fruit on five trees are shown in Table 3.

Table 3. Apple Maggot Infestation Records from Chlordane Sprayed Orchard - 1947

Tree	Variety		No. Apples		Percent Infested
A5	McIntosh		683		21.8
A7	Red Delicious		382		94.5
B2	McIntosh		1151		16.6
E2	McIntosh		794		33.4
E4	McIntosh		507		72.4
		Total	3517	Average	47.7

The 1946 infestation was 30.1 percent. Chlordane is highly toxic to apple maggot flies in laboratory tests but, apparently, under field conditions, it loses its effectiveness rapidly. This orchard is well isolated from other plantings. It is surrounded on two sides by brush-filled fence rows which were not sprayed.

The fruit was heavily infested with codling moth although damage from this insect had not previously been severe.

YAKIMA, WASHINGTON

E. J. Newcomer, In Charge (Fruit Insect Investigations)
and W. E. Westlake, In Charge (Insecticide Investigations).

Seasonal Conditions and Pest Development

The season was one of the earliest we have had, and full bloom of Winesap apples came April 14 at Yakima, 12 days earlier than in 1946 and 18 days earlier than in 1944 and 1945. After May the weather was normal. Codling moths began emerging by April 20, but after early May little could be told about their activity owing to the general use of DDT.

The Pacific mite began migrating into apple trees by March 21. Eggs were being deposited by April 2 and were hatching by April 24. Most of the wintering European red mite eggs hatched between April 4 and 15, and summer eggs were being deposited by April 25.

Spray Materials Used

Because so many new materials were used in 1947, particularly for controlling mites and aphids, they are listed below:

BHC	Benzene hexachloride, 5.7% gamma.
Chlor.	Chlordane, 50% 1068 emulsion.
Cry.	Cryolite
DDT	50% wettable.
DMC	1,1-bis (p-chlorophenyl ethanol. Formerly called di-(para-chloro phenyl) methyl carbinol. 25% emulsible.
DN-111	Dinitro-o-cyclohexylphenol, 20% active.
DT	Methoxychlor. Formerly called dianisyl trichlorethane. 25% wettable.
KOLO	Fused bentonite sulfur.
K-1875	Bis (p-chlorophenoxy) methane, 40%.
Oil	Summer spray oil, 100% active.
SO	Stove oil.
TEP	Tetraethyl pyrophosphate. "9% tetraethyl phosphate, 16% other organic phosphates."
Tox.	A chlorinated camphene (Toxaphene, 50% water miscible.)
Vis-Ko	Rotenone, 1%.
Wett. Sulf.	Wettable sulfur, 95%.
Xan.	Xanthone.
3422	Parathion (0,0-diethyl O-p-nitrophenyl thiophosphate). 15% wettable.
77	Deposit builder.

CODLING MOTH

Spraying experiments were made much as in past years, except that in 1947 most of the tests were designed especially for controlling mites instead of the codling moth. A Winesap orchard was used, which has been used before, and nine of the major tests were made here as well as a number of small tests. A Delicious orchard was also used in which eight major tests were replicated twice and one of them was made once. There were a few Rome trees in this orchard and one of these was included in each test. In each major test eight trees were used, scattered at random, and for the small tests two or three trees were used. From each tree samples of 250 apples were taken at harvest including proportionate quantities of picked and dropped fruit.

No calyx spray was applied to either orchard and there was no evidence that this omission made any difference in the control of the codling moth. In the Winesap orchard four cover sprays were used for controlling the codling moth with most of the materials, applied beginning May 6, May 28, June 16 and July 10. In the Delicious orchard, which had a lighter infestation, three were used, applied beginning May 14, June 5 and July 17.

The results of the major tests on the codling moth are given in Table 1. In orchard A the best control was obtained from the combination of DDT and xanthone. In plot 2, six sprays of DDT at 6 ounces and xanthone at 1 pound were used followed by a seventh spray of xanthone without the DDT. In plot 3, four sprays of DDT at 8 ounces and xanthone at 2 pounds, followed by a fifth spray of xanthone without the DDT, gave about as good control as in plot 2. Where the lower dosage of DDT and xanthone was used in only four sprays (plot 2A) the results were poorer.

Very similar results were obtained in plots 4 and 7, both of which had four sprays of DDT. In plots 5 and 6, the control was poorer, owing to the omission of DDT from the fourth spray. The 1/2 pound of 3422 or the 1/2 pint of TEP used in the fourth spray in these plots did not take the place of DDT for codling moth control.

The three sprays of dianisyl trichlorethane and one of xanthone used in plot 9 apparently did not control quite as well as four sprays of DDT, and since this DDT analog results in a great development of mites and woolly aphids, it seems to have no advantage over DDT. Poorest control of the codling moth, of course, occurred in plot 1, where cryolite was used.

In orchard B, the infestation was so low that very little can be said other than to note the very low percentage of wormy and injured fruit in plot 3 which had three applications of DDT and xanthone, and the comparatively poor results obtained from cryolite. There is no evidence in either orchard that the acaricides influenced the control of the codling moth.

Table 2 gives the results of treatments used on only two trees each, which is not enough to give dependable figures. However, in plot 13, where one less application was made than in the others, the infestation is noticeably higher, and in plot 15 it is noticeably lower, indicating that Toxaphene may have some effect on the codling moth.

Spray Deposits: Analyses of spray residue deposits were made before and after each cover spray for all major treatments which included DDT and for xanthone as the toxicant. Samples were also collected at harvest time for analyses. As in the past, 25 apples were clipped at random from all parts of a tree and collected in a tared container. The average deposits during the spray season and at harvest are shown in Table 2A.

Xanthone was determined by the colorimetric method of Cassil and Hansen and DDT by the colorimetric method originally reported by Stiff and Costello and modified by the Food and Drug Administration. This method employs a pyridine-xanthydrol-potassium hydroxide reagent which couples with DDT to give a red color. Benzene was used to strip DDT from the apples and toluene was used for xanthone.

In all instances the DDT was well below the present tolerance of seven parts per million.

Laboratory tests showed that the addition of lime sulfur to DDT definitely reduced its efficiency against the codling moth. In other tests there was no evidence that an air current reduced the efficiency of benzene hexachloride.

MITES

In March apple tree trunks were sprayed with various materials to kill hibernating Pacific mites. An average of 5 gallons of material was used on large trees and the trunk and the ground area at the base of the trees were thoroughly soaked. The DNOC codling moth spray, or 10 percent emulsified stove oil, resulted in practically 100 percent mortality of the hibernating mites. Dormant oil at 3.2 percent, 2 percent oil with 3 percent lime-sulfur, or 2 percent lime-sulfur alone were ineffective.

The orchard tests for the control of mites are shown in Tables 3, 4 and 5, together with the degree of infestation shortly before harvest, and the size and color of the harvested fruit. The mite sprays were applied whenever needed, regardless of the number, the aim being to effect commercial control with each material. Some were thus used more often than others. Results were obtained on the Pacific mite in the Winesap orchard and on the European red mite in the Delicious orchard. A mite-brushing machine was made available by the Control Division and periodic counts of mites were made in the various plots. Ordinarily 10 medium-sized leaves were taken from fruit spurs on each of the eight

trees in the plot, making a sample of 80 leaves. In the smaller plots, more leaves were used per tree. Counts could not be made as often as would have been desirable, and therefore these results did not always show the situation accurately. Also, late in September, the degree of mite infestation was estimated in the same manner as in previous years. Each tree is given a rating and all trees having the same treatment are then averaged. The ratings are: (3) Large numbers of leaves brown and covered with webbing and considerable migration (for Pacific mite), or many leaves brown or bronzed (for European mite); (2) small numbers of infested leaves and little migration of Pacific mite; (1) very few infested leaves and no migration; and (0) no visible infestation. Any infestation up to 2 is not considered as causing any material injury.

Pacific Mite

Counts were started early in June, and the degree of infestation was determined on September 26.

Cryolite (plot 1, Table 4): This plot was used as a check on the other treatments and is at a disadvantage because practically all of the other plots were sprayed with DDT. The predators were therefore very scarce in the orchard and this plot became more heavily infested than it would have otherwise. The fruit was smaller than in most of the other plots, but color was good.

Xanthone (plots 2, 2A, 3, Table 4): On the whole xanthone did about as good a job as any of the materials used in the eight-tree plots. Infestation stayed rather low until the middle of August, and a flare-up at that time, which could have been headed off by spraying about August 12, was of such short duration that it did very little damage, and the size and color of the fruit was not affected. About 5 percent of spray men using xanthone in the West became afflicted with a dermatitis, apparently caused by it, which is so serious that it is very doubtful whether xanthone should be used.

DN-111 (plot 4, Table 4): In 1945, two applications of this material with DDT effectively controlled the Pacific mite; in 1946, two applications were not enough; and in 1947 it required five applications. The first three were at 1 pound to 100 gallons, which is more than is considered safe, although we had no injury from it. Control was excellent except for a flare-up in August, and the size and color of the fruit were apparently not affected.

Benzene hexachloride (plot 5, Table 4): This was used primarily for controlling woolly aphids, and there is no evidence that it is particularly effective for mites.

Tetraethyl pyrophosphate (plot 6, Table 4): Results from five applications of this material were not quite as good as from five applications of DN-111. The infestation had a tendency to rise rapidly after an application was made, as the eggs were not killed, and it is therefore desirable to apply a second spray about when most of the eggs have hatched. For some reason, the fruit was smaller in this plot than in some of the others, and the color was slightly less.

Parathion (plots 2A and 5, Table 4): The parathion was not received in time to set up a plot for it at the beginning of the season and it was therefore used in two of the other plots later. At 1/2 pound in July in plot 5 it reduced a heavy infestation to zero. Evidently some eggs hatched, however, as in a little over a month the infestation had built up to 40 mites and 40 eggs per leaf, requiring a second application. At 1/4 pound in plots 2A and 5 in August, heavy infestations were very materially reduced. This material appears to be superior to any material used in the large tests.

Rotenone (plot 7, Table 4): It required seven applications of Vis-Ko at 1 pint to control the mites fairly well. Summer oil at 2 quarts improved the control, as did a pint of stove oil. The size and color of the fruit were the same as in the DN plot.

Methoxychlor (plot 9, Table 4): This material was tested primarily for the codling moth. It encouraged the development of mites, and by late June the infestation was so heavy that TEP was used to stop them. Later on, 2 pounds of xanthone was applied, which kept the infestation fairly low for the rest of the season.

Plots 11 to 15 consisted of only four trees each (3 in 12), since most of the materials were new and little was known about their effect on fruit or foliage.

Kolofog (plot 11, Table 5): Seven sprays at 2 pounds gave fair control but not quite as good as from seven sprays of rotenone. No injury to fruit or foliage was noted, although the color of the harvested fruit was not quite as good as in the other small plots.

Chlordane (plot 12, Table 5): Up to early July chlordane controlled the mites well, but it was poor after that. The high cost of the material would appear to make it impracticable to use it any stronger. The color of the harvested fruit was exceptionally good, and there was no injury.

DMC (plot 13, Table 5): This was the most outstanding material used. After three applications with DDT, on May 6, May 28 and June 16, no further spraying was needed for mites. Size and color of harvested fruit were good, although there may have been a very slight foliage injury.

K-1875 (plot 14, Table 5): This material also controlled very well although five sprays were necessary. Unfortunately, about 50 percent of the harvested fruit had russet spots of various sizes on them.

Chlorinated camphene (plot 15, Table 5): Five applications of this material also gave very good control at a very reasonable cost. No spraying was necessary after July 25 and there was no injury. However, this material is not compatible with oil.

European Red Mite

There were a few Rome trees scattered about the Delicious orchard, which the owner sprayed with a pink and calyx spray of 2 percent lime-sulfur for apple powdery mildew. The Delicious were not sprayed. Counts made at intervals during the season showed the following reductions in infestation on the Romes as compared with the Delicious:

Date	Percent Reduction	
	Eggs	Mites
May 14	97	96
June 25	93	84
July 14	48	39
July 23	60	30

This indicates that the mildew sprays have a marked effect on the red mite population, and a dormant oil spray would probably do the same thing. Either might make the use of acaricides unnecessary before the middle of July.

Results of summer sprays in the Delicious orchard were taken from 16 trees in each plot with the exception of 2A, in which there were only eight trees. Counts were started earlier than in the Winesap orchard since the European red mite is naturally distributed over the tree from the beginning of the season. The first cover spray was timed primarily for the codling moth, which was the wrong time for good mite control, as the pest was mostly in the adult and egg stages. Probably the acaricides used in the first cover spray had little effect. There was an average of about four mites, all adult, and 75 eggs per leaf just prior to this spray. This orchard was very thrifty and on good soil, and it may be doubtful whether any of the differences in size and color of fruit are significant.

Cryolite (plot 1, Table 3): Being at a disadvantage, as in the Winesap orchard, the mite population here was rather high after early June until reduced in July with 3422. With one exception, the fruit here was the smallest in the orchard and it had the least color.

Xanthone (plots 2, 2A and 3, Table 3): This material controlled the European red mite better than it did the Pacific mite. Three applications at 2 pounds (plot 3) did a better job than five at 1 pound (plot 2) although no differences showed up in the harvested fruit. About the same mite control was obtained by using three xanthone sprays and two other acaricides (plot 2A) as by using five xanthones (plot 2).

DN-111 (plot 4, Table 3): In spite of two sprays at 1 pound, mite infestation increased rapidly after the middle of June. Since 1 pound of DN-111 is considered unsafe, although we got no injury from it, it was used subsequently at 1/2 pound and the control was not very good. However, there seems to have been little effect on size or color of fruit.

Parathion (plots 1, 2A and 5, Table 3): When used at 1/2 pound in the cryolite plot (1) in July, this material very markedly reduced an infestation of 50 mites per leaf and kept it below 4 per leaf for the rest of the season. Used at 1/4 pound in the BHC plot (5) July 21, where the infestation was lighter, it also kept the mites at a low level for six weeks. In plot 2A it seemed to be less effective at 1/4 pound when used in August.

Tetraethyl pyrophosphate (plot 6, Table 3): By using this material five times good control of the red mite was obtained but not as good as with xanthone. For some reason the fruit was rather small in this plot but the color was normal.

Rotenone (plot 7, Table 3): Five applications of Vis-Ko at 1 pint were somewhat less effective than the TEP. Better results were obtained late in the season by adding summer oil and a little stove oil to it. The size and color of the fruit was normal.

Summer oil (plot 8, Table 3): Control of the mites from five sprays of summer oil just about paralleled that from the same number of sprays of rotenone. The fruit in this plot had the most color and with one exception was larger than in any other plot in the orchard.

Small single-tree tests in this Delicious orchard indicated that DMC and K-1875 were extremely effective against the red mites. The Toxaphene and Dithane were less so.

WOOLLY APPLE APHID

Although the orchard spraying tests were made primarily for controlling mites, the woolly aphid was also given consideration, and in several DDT plots, where the acaricides could not be expected to control it, special applications were made for that purpose. During the season several examinations were made to determine the status of the infestation, and late in September, shortly before harvest, definite counts of nodes were made, 100 nodes on each tree being examined and the percentage infested computed. In the Winesap orchard these percentages were averages of eight trees in plots 1-9, and four trees in plots 11-15; in the Delicious orchard they were from 16 trees each except 2A, where there were only eight trees. The preharvest data are given in Table 6.

Xanthone (plots 2, 2A, 3): The best control of the woolly aphid in both orchards was obtained from the three or four applications of xanthone at 2 pounds in plot 3. Seven applications at 1 pound (plot 2, Winesap) also gave excellent control, but the five applications in plot 2, Delicious, was hardly enough. The substitution of TEP or 3422 for xanthone, as in plot 2A, was of no advantage.

BHC (plots 1, 4, 5): Benzene hexachloride, when used in the first three cover sprays, as in the Winesap orchard (plot 5) reduced the infestation enough so it remained low until the end of the season. Even in the Delicious orchard (plot 5), where it was used only in the first cover spray, at 4 pounds, the infestation remained quite low. The TEP and 3422 used in this plot for mite control may have helped some. Where benzene hexachloride was used after a heavy infestation had developed (plots 1, 4) control was not good unless oil was used with it. The application in plot 4, Delicious, on August 14 with oil reduced the infestation, however, and it was also considerably reduced in plot 1, Winesap, where it was used twice with oil. Where used early, oil does not seem to be necessary, and evidently a couple of early applications at 2 pounds would be enough to control the aphids for the season.

TEP (plots 5, 6): Tetraethyl pyrophosphate has a toxic effect on woolly aphids, as was shown by small tests made in the fall of 1946. In plot 6, where it was used in 1947 at 1/2 pint to 100 gallons for five applications, the woolly aphid was controlled to some extent but not as well as with xanthone or BHC. Its use in plot 5, following BHC, probably had very little additional effect.

Rotenone (plot 7): Although rotenone is supposed to control aphids, and the particular material used in these tests is specifically recommende for controlling the woolly aphid, control in the two orchards used, where it was applied at 1 pint to 100 gallons in five or seven applications, was not outstanding.

Mineral oil (plot 8): Five applications of mineral oil at 2 quarts to 100 gallons had little effect on the woolly aphid.

Parathion: This material, used at 1/2 pound to 100 gallons, in plot 1 in the Delicious orchard on July 17, where a heavy infestation of woolly aphids was developing, had no appreciable effect on them, and this plot had the heaviest infestation in the orchard. The only other plots (2A, 5) in which it was used had been sprayed earlier with BHC or xanthone, and nothing could be told about its effect on the woolly aphid. Repeated or earlier applications might be effective, as the material does kill woolly aphids.

The other new materials were used only on 3 or 4 trees, so that conclusions cannot be too definite. Of the five materials used in plots 11-15, Kolofog, Chlordane and chlorinated camphene appear to have controlled the woolly aphids to some extent. The DMC and the K-1875 appear to have had no effect.

Table 1.--Comparative efficiency of insecticides used in large field spraying experiments for the codling moth. Yakima, Wash. 1947

No.	Treatment (quantities are for 100 gallons)	Orchard A Winesap			Orchard B Delicious		
		No. sprays	% wormy	% injured	No. sprays	% wormy	% injured
1.	Cryolite 3 lbs., mineral oil 1 qt.[1], Colloidal 77, 1/6 lb.	7	7.9	16.1	5	1.7	3.8
2.	DDT 6 oz., xanthone 1 lb. (1½ lbs. Genicide A), stove oil 1/4 to 1 pint[2]	7	1.6	3.0	5	0.4	1.0
2A.	Do., fewer applications[3]	4	6.0	10.2	3	0.7	1.4
3.	DDT 8 oz.[4], xanthone 2 lbs., stove oil 1 pint, Colloidal 77, 1/12 lb.	5	2.4	5.0	3	0.1	0.3
4.	DDT (50%) 2 lbs. 1st spray; 1 lb. other sprays; DN-111 for mites	4	2.8	5.2	3	0.2	0.7
5.	Do., BHC 2 lbs. for woolly aphids; 3422[5] 1/4-1/2 lb. for mites	3	6.6	10.6	3	0.3	0.6
6.	Do., TEP 1/2 pint for mites and aphids	3	5.7	9.2	3	0.7	1.5
7.	Do., rotenone (Vis-Ko) 1 pint for mites and aphids	4	3.3	4.9	3	0.7	1.5
8.	Do., mineral oil 2 qts. for mites	-	-	-	3	0.3	1.1
9.	Dianisyl trichlorethane[6] (Ortho-Tox) 2 lbs., 3 covers; xanthone 2 lbs., 4th cover	4	4.2	5.5	-	-	-

Note: No calyx spray applied. See tables 3 and 4 for details of mite sprays.

1/ Orchard A: 2 qts in 6th and 7th; no cryolite in 7th; BHC 2 lbs. for woolly aphids in 5th, 6th and 7th. Orchard B: Oil omitted and 1/2 lb. 3422 substituted in 5th spray.

2/ Orchard A: DDT omitted from 7th spray.

3/ Extra sprays of TEP (a tetraethyl phosphate) or 3422 (a thiophosphate) applied for mites.

4/ DDT omitted from 5th spray.

5/ Parathion

6/ Methoxychlor

Table 2. Comparative Efficiency of Insecticides Used in Small Field Spraying Experiments for the Codling Moth. Yakima, Washington - 1947

No.	Treatment (Quantities are for 100 Gallons)	Orchard A - Winesaps		
		No. Sprays	Percent Wormy	Percent Injured
11	DDT (50%) 2 lb., 1st spray; 1 lb., other sprays; Kolofog 2 lb. for mites	4	4.2	6.2
12	DDT (50%) 2 lb., 1st spray; 1 lb., other sprays; Chlordane 8 oz. for mites	4	3.2	4.4
13	DDT (50%) 2 lb., 1st spray; 1 lb., other sprays; DMC 1-1/2 pints for mites	3	8.4	12.6
14	DDT (50%) 2 lb., 1st spray; 1 lb. other sprays; K-1875 2 lb. for mites	4	4.0	5.2
15	DDT (50%) 2 lb., 1st spray; 1 lb., other sprays; Toxaphene 1 pint for mites	4	1.4	4.0

Note: No calyx spray applied. See Table 5 for details of mite sprays.

Table 2A. Average Spray Residues in Micrograms per Square Centimeter and Residue at Harvest in Parts per Million. Yakima, Wash., 1947

Treatment No.	Residue	Winesap			Rome		
		Before Spray mg/cm^2	After Spray mg/cm^2	Harvest ppm	Before Spray mg/cm^2	After Spray mg/cm^2	Harvest ppm
2	DDT	2.6	7.0	---	1.8	4.1	---
	Xanthone	4.0	16.5	---	2.3	8.9	---
3	DDT	2.3	6.9	---	1.2	6.2	---
	Xanthone	3.6	27.3	---	1.8	19.8	---
4	DDT	2.9	9.5	3.37	1.9	8.6	2.03
5	DDT	2.5	7.3	1.86	2.2	9.5	1.71
6	DDT	3.1	8.0	1.79	2.2	10.1	2.08
7	DDT	3.9	7.8	5.44	2.7	7.2	2.93
8	DDT	---	---	---	4.7	10.8	4.13

Table 3.--Degree of mite infestation and size and percentage of extra fancy apples resulting in plots sprayed for the European red mite. Yakima, Wash., 1947.

Plot	Treatment (particularly for mites) (quantities are for 100 gallons)	Degree of infestation Sept. 19	Size of apples (Ave. No. per orchard box)	% Extra fancy apples 1/
1.	Cryolite 3 lbs., 5 applic.; 3422 2/ 1/2 lb. added to last applic. (in July)	0.9	97	57
2.	Xanthone 1 lb., DDT 6 oz., 5 applic.	0.5	89	70
2A.	Xanthone 1 lb., DDT 6 oz., 3 applic.; TEP 1/2 pint, 1 applic.; 3422 2/ 1/4 lb., 1 applic.	0.0	80	60
3.	Xanthone 2 lbs., DDT 8 oz., 3 applic.	0.1	92	67
4.	DN-111, 2 applic. at 1 lb.; 2 applic. at 1/2 lb.; BHC 2 lbs. added to 4th; BHC 2 lbs. and oil, 1 applic.	0.5	94	69
5.	BHC 4 lbs., 1 applic.; TEP 1/2 pint, 2 applic.; 3422 2/ 1/4 lb., 1 applic.	0.3	88	71
6.	TEP 1/2 pint, 5 applic.	0.7	98	70
7.	Rotenone (Vis-Ko) 1 pint and oil, 5 applic.	1.2	95	69
8.	Summer oil 2 qts., 5 applic.	1.8	83	75

Note: DDT used in 3 applications in plots 4, 5, 6, 7 and 8.
1/ Based on color only.
2/ Parathion

Table 4.--Degree of mite infestation and size and percentage of extra fancy apples resulting in large plots sprayed for the Pacific mite. Yakima, Wash., 1947.

Plot	Treatment (particularly for mites) (quantities are for 100 gallons)	Degree of infestation Sept. 26	Size of apples (Ave. No. per orchard box)	% Extra fancy apples 1/
1.	Cryolite 3 lbs., 6 applic.; BHC 2 lbs. added to 5th and 6th; BHC 2 lbs. plus oil, 1 applic.	0.5	126	66
2.	Xanthone 1 lb., DDT 6 oz., 7 applic. (DDT omitted from 7th)	0.9	117	68
2A.	Do., 4 applic.; TEP 1/2 pint, 1 applic.; 3422 2/ 1/4 lb., 1 applic.	1.0	117	67
3.	Xanthone 2 lbs., DDT 8 oz., 5 applic. (DDT omitted from 5th)	0.8	119	65
4.	DN-111, 3 applic. at 1 lb.; 2 applic. at 1/3 lb., BHC 2 lbs. added to 4th	1.4	114	66
5.	BHC 2-4 lbs., 3 applic.; TEP 1/2 pint, 1 applic.; 3422 2/ 1/4-1/2 lb., 2 applic.	0.5	117	67
6.	TEP 1/2 pint, 5 applic.	1.1	121	64
7.	Rotenone (Vis-Ko) 1 pint, 7 applic.	1.8	125	51
9.	Dianisyl trichlorethane 3/ 2 lbs., 3 applic.; TEP 1/2 pint, 1 applic.; xanthone 2 lbs., 1 applic.	2.0	120	68

Note: DDT used in 4 applications in plots 4 and 7, and in 3 in plots 5 and 6.
BHC = benzene hexachloride; TEP = tetraethyl phosphate.

1/ Based on color only.
2/ Parathion
3/ Methoxychlor

Table 5. Degree of Mite Infestation and Size and Percentage of Extra Fancy Apples Resulting in Small Plots Sprayed for the Pacific Mite. Yakima, Washington - 1947

Plot	Treatment (particularly for mites) (Quantities are for 100 Gallons)	Degree of Infestation Sept. 26	Size of Apples (Av. No. per orchard box)	Percent Extra Fancy Apples 1/
11	Kolofog 2 lb., 6 applications; wettable sulfur 3 lb., 1 application	0.5	113	48
12	Chlordane 1/2 lb., 7 applications	1.7	116	83
13	DMC 1-1/2 pt., 3 applications	0.0	98	64
14	K-1875 2 lb., 5 applications	0.0	110	54
15	Toxaphene 1 pt., 5 applications	0.5	93	53

Note: DDT used in three applications in plot 13, and in four in the other plots.

DMC = 1,1-bis (p-chlorophenyl) ethanol, 25% emulsible.

K-1875 = bis (p-chlorophenoxy) methane, 40%.

1/ Based on color only.

Table 6. Woolly Apple Aphid Infestation in Mite Control Plots
Yakima, Washington - 1947

Plot	Treatment (Quantities are for 100 Gallons)	Percent Infested Nodes in September	
		Orchard A Winesaps	Orchard B Delicious
1	Cryolite 3 lb., mineral oil 1 qt. Colloidal 77, 1/6 lb.1/	10.6	53.5
2	DDT 6 oz., xanthone 1 lb., stove oil 1/4 to 1 pt.	7.9	19.2
2A	do, but TEP 1/2 pt. substituted in late June, + 34222/ 1/4 lb. in mid-August	14.1	19.4
3	DDT 8 oz., xanthone 2 lb., stove oil 1 pt., Colloidal 77, 1/12 lb.	1.5	6.1
4	DDT (50%) 2 lb., 1st spray; 1 lb. other sprays; DN-111 for mites; BHC 2 lb. in July (Orch. A and B) and August (Orch.)	43.9	20.6
5	DDT, as above; BHC 2 lb. 1st 3 sprays (Orch. A), 1st spray only (Orch. B); TEP 1/2 pt. in June, 34222/ 1/2 lb. in July and August	5.3	14.9
6	DDT, as above; TEP 1/2 pt.	28.0	28.9
7	DDT, as above; Rotenone (Vis-Ko) 1 pt., mineral oil 1 pt. - 2 qt.	25.4	40.0
8	DDT, as above; Mineral oil 2 qt.	--	43.2
9	Dianisyl trichlorethane 3/ 2 lb., 3 sprays; TEP 1/2 pt. 4th spray; xanthone 2 lb., 5th spray	16.0	--
11	DDT (50%) 2 lb., 1st spray; 1 lb. other sprays; Kolofog 2 lb.	19.0	--
12	DDT, as above; Chlordane 8 oz.	14.3	--
13	DDT, as above; DMC 4/ 1-1/2 pt.	48.0	--
14	DDT, as above; K-1875 5/ 2 lb.	46.7	--
15	DDT, as above; Toxaphene 1 pt.	13.0	--

1/ Orchard A: BHC 2 pounds for woolly aphids in 5th, 6th and 7th sprays;
Orchard B: 1/2 pound 3422 instead of oil in 5th spray.

2/ Parathion

3/ Methoxychlor

4/ 1,1-bis (p-chlorophenyl) ethanol

5/ Bis (p-chlorophenoxy)methane